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THE LINDE ICE MACHINE.

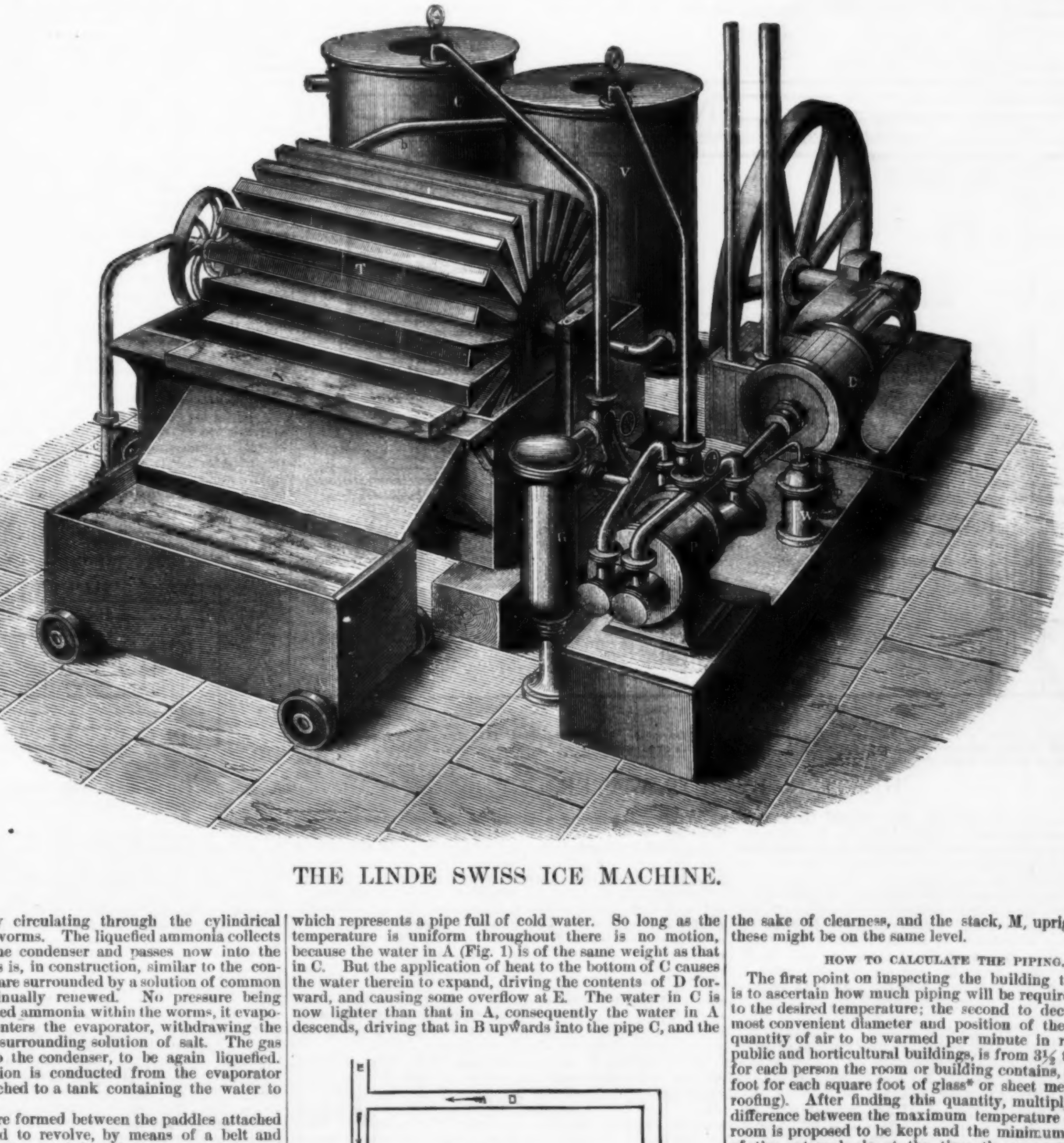
THE accompanying engraving represents an ice machine manufactured under the Linde patent by the Sulzer Bros., Wintherthur, Switzerland. One of these machines was kept in constant operation at the Paris Exhibition, and the manufacturers were rewarded by a medal for the same.

Like most of the machines for this purpose, the Linde apparatus utilizes the absorption of the latent heat of water by liquefied ammonia gas. The latter is generated from ordinary aqua ammonia in a boiler. After passing through a rectifier and condenser, in which it is freed from water and other impurities, it enters, through the tube, *b*, the condenser, C. The latter consists of a sheet-iron cylinder containing a number of concentric worms. While the gas passes through the worms, it is exposed to the action of a horizontal double-acting compression pump, P, while cold water is continually circulating through the cylindrical vessel inclosing the worms. The liquefied ammonia collects at the bottom of the condenser and passes now into the evaporator, V. This is, in construction, similar to the condenser. The worms are surrounded by a solution of common salt, which is continually renewed. No pressure being applied to the liquefied ammonia within the worms, it evaporates, as soon as it enters the evaporator, withdrawing the latent heat from the surrounding solution of salt. The gas is again conducted to the condenser, to be again liquefied. The cooled salt solution is conducted from the evaporator to a refrigerator attached to a tank containing the water to be frozen.

The cakes of ice are formed between the paddles attached to a drum, F, caused to revolve, by means of a belt and pulley, within the tank containing the water, at a rate of 6 revolutions per minute. In its interior liquefied ammonia is constantly caused to evaporate. The water contained in the tank is thus cooled by coming into contact with the paddles of the drum and by the salt solution contained in the refrigerator. The surfaces of the paddles are, at each immersion, covered with a layer of ice, and at the end of ten hours the spaces between the paddles are completely filled. The supply of ammonia gas is now cut off and the salt water removed from the refrigerator. Steam is passed through the drum, and the cakes of ice may now be readily taken out and removed. During this operation the speed of the drum is reduced to ¼ of a revolution per minute.

The cakes weigh 35 pounds each. An apparatus of ordinary capacity, freezing 72 cakes at a time, furnishes therefore about 1¼ ton of ice within ten hours.

The parts of the machine coming into contact with the ammonia vapor are lubricated with glycerine, which, unlike the fatty lubricants, is not affected by ammonia. The machine is constructed entirely of iron—the best metal for an apparatus, so many parts of which are exposed to the action of ammonia in its most concentrated form.—*Schweizer Gewerbeblatt.*



THE LINDE SWISS ICE MACHINE.

HEATING BY HOT WATER.*

By A HOT WATER ENGINEER.

MULTIFARIOUS as are the varieties of buildings the hot-water engineer is called upon to warm, he may rest assured of achieving success if he keeps steadily before his mind's eye the natural principles which control the action of hot-water apparatus. The cause of circulation of the water will be at once mastered by means of the following diagram, which represents a pipe full of cold water. So long as the temperature is uniform throughout there is no motion, because the water in A (Fig. 1) is of the same weight as that in C. But the application of heat to the bottom of C causes the water therein to expand, driving the contents of D forward, and causing some overflow at E. The water in C is now lighter than that in A, consequently the water in A descends, driving that in B upwards into the pipe C, and the

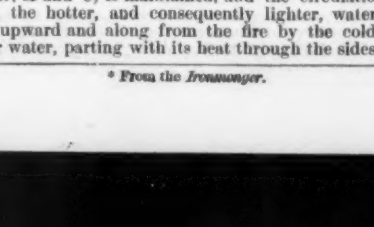


Fig. 1.

original contents of C towards A. Heat continuing to enter the pipe C, the difference in the weights of the two columns of water, A and C, is maintained, and the circulation continued, the hotter, and consequently lighter, water being forced upward and along from the fire by the colder and heavier water, parting with its heat through the sides of the pipe on its way, and as it cools, driving in its turn freshly-heated water before it. It follows, therefore, that the greater the difference in temperature, and consequently weight, between A and C, the more rapidly will the water travel, and to a certain degree the greater will be the quantity of heat given off per minute. This difference in temperature is neither more nor less than the *motive power* of the apparatus. Thus we have in water an excellent medium for distributing at a nearly equable degree from every part of the apparatus the heat derived from the fire.

To avoid loading this article with unnecessary drawings, the reader is requested to provide himself with a manufacturer's sheet of drawings of parts and fittings. Fig. 2, on next page, is a composite sketch representing numerous combinations of fittings, and is intended to illustrate, by means of one engraving, different arrangements of apparatus. Moreover, the return-pipes are drawn under the flow-pipes for the sake of clearness, and the stack, M, upright, while all these might be on the same level.

HOW TO CALCULATE THE PIPING.

The first point on inspecting the building to be warmed is to ascertain how much piping will be required to warm it to the desired temperature; the second to decide upon the most convenient diameter and position of the pipes. The quantity of air to be warmed per minute in rooms, and in public and horticultural buildings, is from 3½ to 5 cubic feet for each person the room or building contains, and 1¼ cubic foot for each square foot of glass* or sheet metal (*e.g.*, iron roofing). After finding this quantity, multiply 125 by the difference between the maximum temperature at which the room is proposed to be kept and the minimum temperature of the external air at the time the apparatus will be at work, and divide this product by the difference between the working temperature of the pipes (which is generally 180° F.) and the proposed temperature of the room; then the quotient thus obtained, when multiplied by the number of cubic feet of air to be warmed per minute, and this product divided by 222, will give the quantity, in lineal feet, of 4-inch pipe necessary to produce the desired result.

The foregoing rule is rather a long one, but it is a good one, and by it a table of quantities of pipe may be calculated for immediate reference at any time. If 3-inch pipes are used, one-third more, and if 2-inch, double the quantity of 4-inch will be necessary.

The following data (the quantities are given in 4-inch

* From the *Ironmonger*.

* In measuring the area of glass exclude all wood sash-bars. The area of wood in horticultural buildings is generally one-eighth of the whole.

pipe) are derived from general experience, and are given as general guides only in the case of buildings which have nothing extraordinary in their plan or design; but not as superior to the results yielded by the use of the foregoing rule: To maintain a temperature of 55° F., allow for each 1,000 cubic feet of space in public buildings,* from 5 to 7½ feet of pipe, according to the efficiency of the ventilation; in dwelling rooms, 9 feet; in halls, shops, and waiting rooms, 10 feet; in schools, 6½ feet; and in manufactories, 6 feet.

In horticultural buildings allow, to maintain a mean temperature in the coldest weather of 55°, 35 feet; of 65° to 70°, 45 feet; of 70° to 75°, 50 feet; and of 80°, 55 feet.† Rooms for drying wet linen must have 150 feet of 4 inch pipe, and for curing bacon, drying paper or leather, from 20 feet to 30 feet per 1,000 cubic feet of space. For public and horticultural buildings, 4 inch pipes are the best, because they cool less rapidly than smaller ones, but for shops and houses 2 inch or less may be used. Pipes have often to be placed in trenches covered with iron grating to be out of the way. A 10 foot pipe on the floor gives off as much heat as 11 foot in a grating covered trench.

This loss of heat and extra cost of fixing may be turned to good account by laying 2 inch rain pipes from the outer air under the floor to discharge on a level with the bottom of the trench. By this means the ventilation of the building will be materially improved. Where it is impossible to get upon the floor the necessary quantity of piping recourse must be had to coils or stacks. The latter consist of lengths of pipe arranged between siphons. Like coils they can be made of any size, but offer less resistance to the flow of the water than coils of equal heating power. These should be placed near any outer door or staircase head, that the large quantity of heat they give off may grapple with the cold immediately on its entrance.‡

Flow and return pipes must always be horizontal. It is an utter fallacy to suppose that giving the flow pipe a rise from, and the return pipe a fall to, the boiler facilitates the circulation; on the contrary, it is then positively retarded. When pipes have to pass underground in a brick trench or through

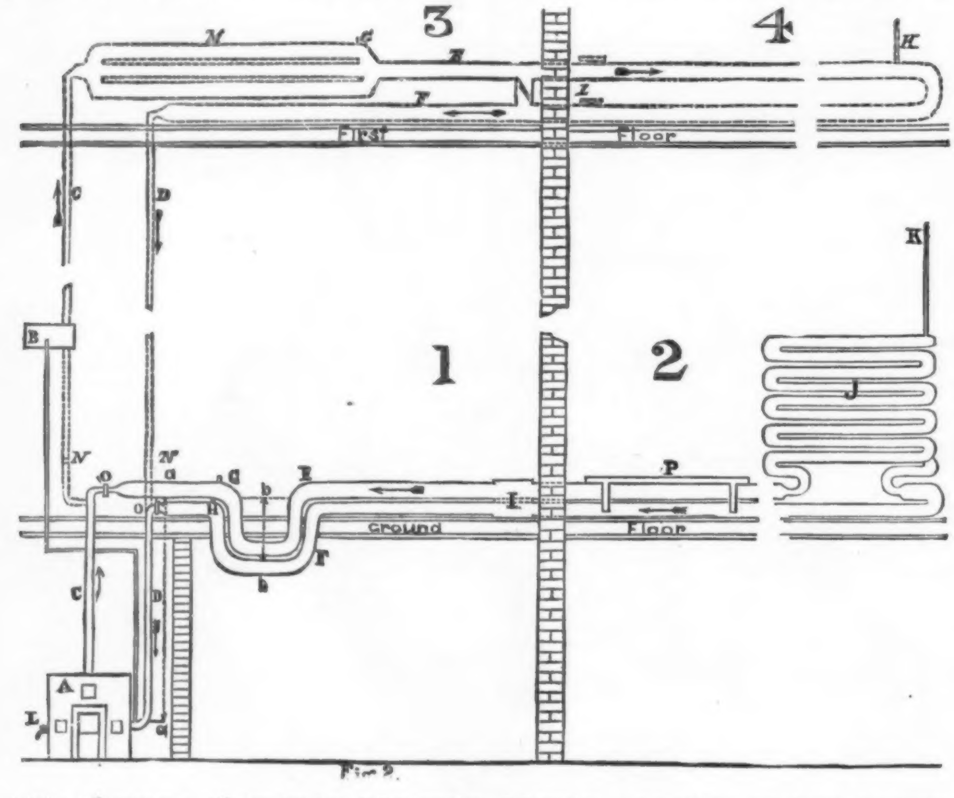


Fig. 2.

A, boiler. B, supply-cistern. C C, ascension-pipes. D D, descent-pipes. E E, flow-pipes. F F, return-pipes. G H, air-vents. I, compound valve, doing the work of three ordinary check-valves as fixed at I. J, coil. K K, air or expansion pipes. L, draw-off cock. M, stack. N O, check-valves in pairs. P, movable water-trough.

HEATING BY HOT WATER.

rooms where heat is not required, they should be packed with hair felt, an inch thick. G H F E (Fig. 2) represents what is known as a dip, rendered inevitable by the presence of doorways, etc. They should be avoided when possible, as they seriously check the circulation (see further on under Boilers). If there is not room for the pair of pipes under the doorway, etc., they may be reduced in diameter at each connection with the flow and return pipes. It is often required to stop a circulation at certain points. The three check-valves, I (Fig. 2), cut off No. 4 room; the pair, N N, cut off the entire first floor; the one compounded valve, I, does the same for No. 2 room, while the pair, O O, confine the circulation to No. 3 room, or the first floor.

With 4 inch pipes valves as small as 2 inch may be used, attached by means of diminishing nipples, but it would not be worth while to make any alteration with pipes as small as 2 inch. A powerful hot-water apparatus on a clear wintry day will make the air too dry for healthy respiration. In such cases, or where excessive moisture is required, use movable shallow water troughs, P (Fig. 2), made of stout tin-plate or coated iron. One hundred feet of cast iron pipe at 212° F. expands lengthwise 1⅜ inch. Small as this expansion is it is irresistible, and unless provision is made for it by using rollers under the pipes or India-rubber joints, fracture of some part of the apparatus is sure to ensue. The presence of bends in a run of pipes imparts a small degree of elasticity.

* The result obtained in calculating for many kinds of churches by the rule is much less than that afforded by the above data. This difference is owing to the variable quantity of glass, and to the fact that, as a rule, churches are heated only once or twice a week. If very divergent results are obtained adopt the mean quantity of pipe.

† These quantities are frequently distributed at different levels, to afford top and bottom heat. Even higher quantities, with increased ventilation, are sometimes used to secure a finer frontage.

‡ This is a point of great importance. If the floor-pipes laid in a public building are only enough just to warm it, and no provision be made to neutralize the effect of rushes of cold air, it will be found that in consequence of the rarefaction of the warmed air, the indraught of cold air will be greater than before the apparatus was introduced.

Ascension pipes should always be taken vertically to the highest point direct from the boiler. Conducting them through a flue results in a small economy of fuel.

Neither ascension nor descent pipes, C C D D, need be as large as the flow or return pipes, because water travels so much more rapidly in a vertical than in a horizontal pipe. If the horizontal pipes are 4 inch the vertical may be 2 inch, and even 1 inch in an apparatus of a moderate size. With a brisk circulation the supply pipes may be smaller than with a slow one, but regard must always be had to the total quantity of water to be carried. So with horizontal branch pipes leading from a central boiler to several houses. Where the total quantity of heating pipe is, say, 300 feet, the branch pipes should not be less than 2 inch.

Fig. 2. shows one way of arranging the ascension pipe, where several floors have to be heated, by the insertion of branch pipes to check the rise of the water in C, and induce its passage towards G. Were it not for some such arrangement the whole of the hot water would at once pass to the top floor. The ascension pipe may be reduced from, say 3 inch for the ground floor to 2 inch for the first and second, and to 1 inch for the third floor. But a better plan is to have a separate ascension for each floor, although only one descent pipe for all the floors need be used. In addition to the socket and spigot pattern pipe there are now several other patterns which, from the ease with which the joints are made, deserve a careful attention. It is often a great convenience to be able to take up a set of pipes and put them away for the summer, refixing them on the approach of cold weather.

CEMENTS FOR IRON PIPES.

The strongest cement for socket joints consists of 10 lbs. of iron borings and 1¼ lb. of powdered sulphur mixed and moistened with water as it is wanted for immediate use.* The joint is first calked tight with spun yarn one third of its length, and finished with the cement, layer by layer, and calked. The disadvantages of a cement so hard as this are the risk of bursting a socket from too tight calking, the impossibility of undoing a joint, and the tediousness of the process.

Any of the following are preferable except in the case of coils and upright stacks, and where the pipes pass through flues, or at the point of connection with the boiler. The iron cement may be replaced by Portland cement, a mixture of red and white lead, or an India-rubber ring of a circular section driven into the socket, with a boxwood calking tool or spring, into its place. Sometimes these rings can be used without calking with yarn.† These rings should fit the spigot pipe tightly, and in thickness of material be $\frac{1}{16}$ inch more than the joint space. Pipes with plain ends jointed by means of nipples of India-rubber, about 3 inches long by ¼ inch thick, gripped by a copper or iron clamp, would answer every purpose, and longitudinal gills cast upon their surface would materially increase their efficiency.

The expulsion of air from the pipes at the time of filling, as well as provision for the escape of such air as is boiled out of the water, is effected by means of air-vents and tubes. The ¼-inch iron tubes, K K, Fig. 2, answer this purpose, as well as allowing for the expansion of the water. They should be carried up a foot higher than the supply cistern and turned into it, or anywhere where the occasional discharge of a pint of warm water would not be objected to.

To ascertain at what points air is likely to lodge, imagine you see the water rising in the apparatus as it is filled. Water may drive water along a pipe, but not down one. Wherever, therefore, the air would be penned, as at G G and at H, either pipes or small brass cocks must be fixed. The supply cistern, B, may be fixed anywhere, provided that its bottom is higher than the flow pipe. It should deliver into the return pipe by means of a ¾-inch iron pipe fitted with a strainer to keep out dirt.

* Fifty 4 inch joints require 100 lbs. borings, 1¼ lb. sulphur, and 10 lbs. yarn.

† The pressure upon any part of a hot water apparatus is 1 lb. per square inch for every 2 feet of vertical (not sloping) distance separating that part from the water level in the cistern. There may be any number of pipes attached to the boiler, or any quantity of water in the cistern and pipes, the pressure will be only as above stated. So that it is very easy to test the strength of any kind of joint proposed to be used.

THE SUPPLY CISTERN.

The capacity of the supply cistern should be $\frac{1}{16}$ that of the pipes and boiler. Fifty feet of 2-inch pipe hold 7 gallons; of 3-inch, 15 gallons; and of 4-inch, 27½ gallons; 277 cubic inches =1 gallon. Rain water is certainly the best for use in a heating apparatus, but if only very hard water can be had, dissolve an ounce of powdered sal ammonia to each 10 gallons of water to prevent sediment. Fig. 3 shows another position for the cistern. With this arrangement the

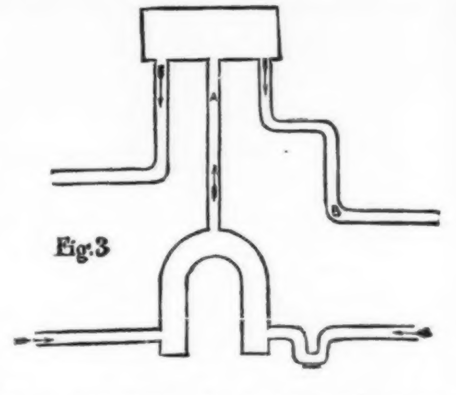


Fig. 3

boiler may be on the same floor level as the pipes, and there may be any number of circulations. To stop any one it is only necessary to put a wood plug in the descending pipe, where it is joined to the cistern, and have a valve or an inverted siphon in the return pipe. This arrangement, however convenient, cannot be recommended, on account of the escape of heat from the cistern, and if this escape is prevented by the use of a jacket of felt, the difference in the temperature of the pipes, A and B, would be so little as to produce only a feeble circulation.

THE BOILER.

Boilers are of various shapes, and of either wrought or cast iron, the latter rusting less than the former. The saddle pattern is an excellent one, and has been much improved during late years. There are now made several patterns which do not require any brickwork setting, and where space is at a premium these boilers deserve attention. To calculate the power of a boiler, add to the square feet* exposed to the direct or radiant heat of the fire one-third of the flue surface (*e.g.*, the outside of a saddle or tubular boiler), and refer to the following table. It is wise to use a boiler one-fifth larger than indicated in the table, as by doing so fuel can be consumed more economically. When a fire has to be kept in through the night, a larger boiler than would suffice to heat the pipes may have to be used. 4, 6, 8, 10, 14, and 20 square feet of boiler surface will heat 200, 300, 400, 500, 700, and 1,000 feet of 4-inch pipe.

A boiler set in brickwork should have tightly-fitting fire and ash doors, with a regulator in the latter, a damper, check-draught, and a full complement of soot doors. 200 feet of 4-inch pipe require a fire grate with an area of 100 square inches, and other quantities in proportion. Feather edge bars are decidedly superior to the ordinary pot grates. A dead plate, on which to coke each fresh supply of fuel before it is pushed into the fire proper, is advisable. (See Fig. 4.) The higher the flue is carried the sharper and more

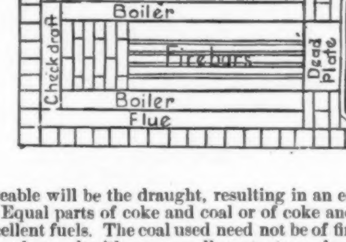


Fig. 4

manageable will be the draught, resulting in an economy of fuel. Equal parts of coke and coal or of coke and spent tan are excellent fuels. The coal used need not be of first quality. Gas may be used with very small apparatus where it would be more convenient than coke or coal. Its cost as compared with that of coal is as ten to one.

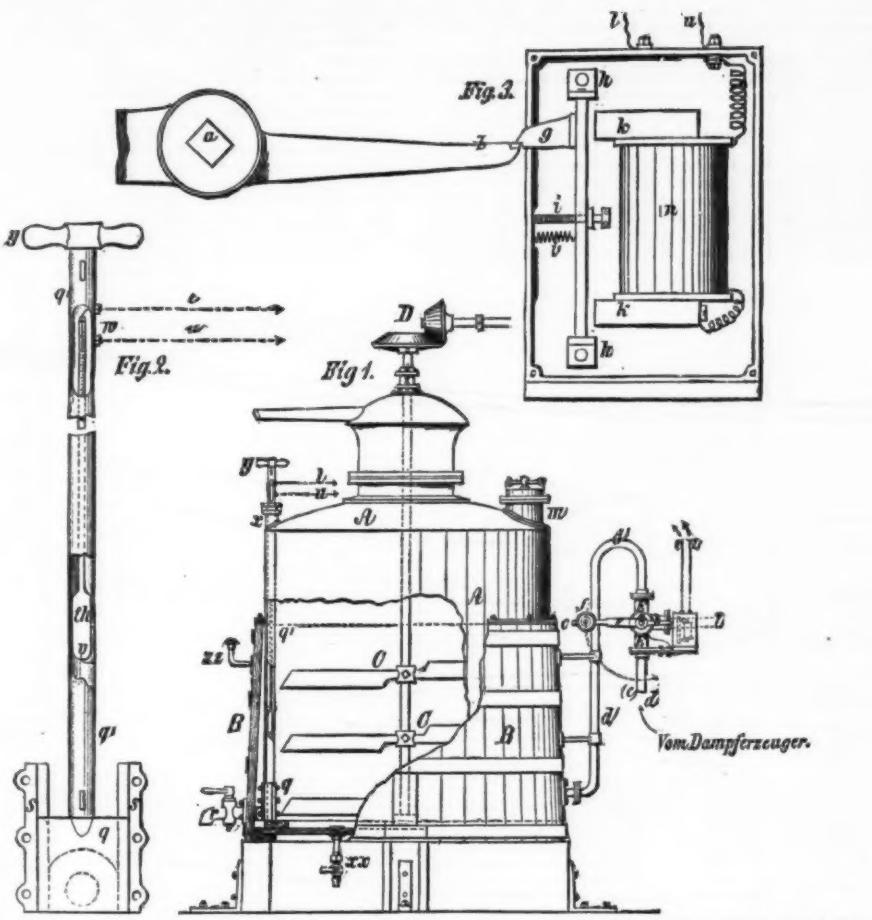
The boiler should be made of copper or stout tinned iron, circular in shape, and with a flue. The boiler of a hot water apparatus should always be fixed in a shed or some place not communicating with the room to be heated. It may be either at one end or in the center of the system of pipes. The lower the boiler is sunk the more rapid will be the circulation, and the more easily will the obstacles to the free flow of the water presented by elbows, dips, stacks, and coils be overcome. Where there are no dips or coils a distance of 12 inches between the flow and return pipe at *a a*, Fig. 2, will produce a circulation; and where there is a dip the distance, *b b*, must be added to *a a*. If this dip exceeds 4 feet in length, or there are more than one dip, the increased depth of the boiler pit must be one and a half times *b b*. Extra depth, too, must be allowed for stacks and coils. It is sometimes desirable to make the pipe descend below the boiler into a lower room. This can only be done when, by having a high ascension pipe, and the flow pipe rapidly cooled, a quick circulation is maintained.

With a low-pressure apparatus as described in this paper, the worst that could result from the fracture of a pipe or joint would be a leakage of warm water. The tools required in fixing a hot water apparatus are calking tools and hammers, a portable bench, vise, and forge, chisels for cutting through walls, taps, dies, and cutter for wrought iron pipes, a Chatwin's pipe cutter for cast iron pipes, a wooden straight-edge, 10 feet long, a spirit level, cement bowls, files, a joiner's chisel, etc. The writer, in conclusion, wishes to acknowledge the great assistance he has received in his career as a hot water engineer from Mr. C. Hood's excellent and comprehensive work on the subject.

* One square foot of surface exposed to the fire receives as much heat as 3 square feet heated by the draught through the flue.

IMPROVED VARNISH BOILER WITH AUTOMATIC REGULATOR.

ONE of the principal difficulties experienced in manufacturing varnishes arises from the frequent boiling over of the mass, as soon as the boiling point is reached. It is, therefore, desirable to conduct the whole operation at a temperature below the boiling point. To accomplish this purpose Mr. John Werner has constructed a new boiler with automatic, electric regulation of heat, which is illustrated by the accompanying engravings.



IMPROVED VARNISH BOILER WITH AUTOMATIC REGULATOR.

It consists of an iron boiler (Fig. 1), A, inclosed in a wooden casing, *b*, so as to leave ample space between their bottoms. The material is filled into the boiler through a short tube, *m*, which is closed by a screw cover. The boiler contains an agitator, C, of the usual form, which is operated by hand or power transmitted to the cogwheels, D. The boiler may be emptied through a pipe provided with a stopcock, *r*.

To prevent a premature discharge of the contents of the boiler by an accidental opening of the stopcock, *r*, a slide valve is provided, represented by Fig. 2. It runs in guides, *s s*, and fits accurately in them and to the disk of the stopcock, *r*. The metal pipe, *q*, *q*, connected with the slide, *g*, is packed tightly at *x*, and provided with a handle, *y*.

As stated above, the proper regulation of heat in the process of boiling varnish is of the utmost importance, owing to the dangerous nature of the material operated upon. For accomplishing this end Mr. Werner has devised a most ingenious apparatus.

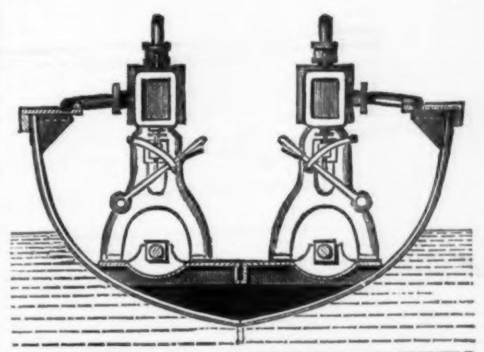
Within the cylinder, *q*, of the slide, *g*, there is contained a thermometer, *th*, the bulb of which is situated near the central portion of the boiler, so as to be continually surrounded by the heated mass. The portion of the thermometer containing the scale is made visible by removing a portion of the wall of the cylinder, *q*. A platinum wire penetrates the bulb of the thermometer and is immersed in the mercury; its other extremity is connected with the hollow cylinder. The upper end of the thermometer is tightly closed by a cork, *w*, through which another platinum wire passes, which is easily adjustable, so that it may be made to project more or less into the thermometer. An electic current is passed through the apparatus by means of wires, *e* and *u*. One of these is attached to the platinum wire passing through the cork, the other is soldered to the hollow cylinder, *q*.

Steam is conducted into the chamber under the boiler through a three-port valve, *c*, and tube, *d* and *d'*. Hereby the boiler and its contents are heated. When the steam is cut off, it passes through the tube, *l*. The water condensed in the steam chamber is drawn off through a tube, *x x*. *z z* is an air valve through which air may be exhausted, when steam is cut off, to prevent the formation of a vacuum. The key, *a*, is connected with a double lever, *e e b*, the left arm of which carries a weight, *f*. The stopcock is constructed so that when the lever is in horizontal position, as in Fig. 1, the steam passes into the steam-chamber; when the position of the lever is vertical, steam is cut off. This is done when the weight, *f*, is released, which is ordinarily held in horizontal position by the arm, *g*, of the armature, *h h*, of an electro-magnet formed by a coil of copper wire and two iron plates, *k k*, attached to the same. The armature is, when steam is being conducted into the steam-chamber, held in position by a spring, *i*, and a screw, *j*. As soon as a current is passed through the coil by means of the wires, *l* and *u* (Fig. 3), the armature is attracted by the electro-magnet, the lever, *b*, escapes, and the communication between the pipe, *d*, and the steam-chamber is cut off. To regulate the apparatus so that a certain temperature is not exceeded, we, therefore, only need to adjust the movable platinum wire in the thermometer, so that the inner end reaches the point on the scale indicating the required degree of heat, for instance, 150°. As soon as that temperature is reached the mercury will touch the wire. The electric current is thereby closed, the lever released, and the supply of steam is cut off at once. As soon as the temperature is reduced, steam will be readmitted under the boiler.

Of course this ingenious device may be applied to all apparatus in which an accurate regulation of heat is desirable. Considering the great danger attending the manufacture of varnishes, and the frequency of accidents from overheating the contents of varnish boilers, this device for regulating the heat will be found a most useful addition to the boilers at present in use.—*Deutsche Gewerbe Zeitung.*

TWIN SCREW STEAM LAUNCH.

WE illustrate an iron twin screw steam launch, built for passenger service in shallow waters in the East Indies, by Messrs. Edwards & Symes, of Cubitt Town, London, who have given special attention to the construction of shallow draught vessels, some of which we have already illustrated. The boat illustrated is one of three built for Mr. W. Walker, of London. They are of different sizes, one being entirely of steel, but all propelled with twin screws. It is 56 ft. long, 7½ ft. beam, and 3 ft. 9 in. deep; draught of water aft 2 ft. 9 in.; and is fitted with a wood sun awning the whole of its length, the forward part carrying an additional canvas awning above the wood awning, so forming a double top in the hot season. The fore and after compartments are fitted with seats, constructed of East India teak, polished, for passengers. The machinery for propelling the boat consists of a pair of high-pressure inverted direct-acting engines, with cylinders 7 in. diameter; the bed plates are bolted together and designed specially for durability. Each engine is fitted with a gun metal feed pump, which by a suitable arrangement of pipes can draw from the bilge or sea, and discharge overboard or into the boiler, and also with a hand feed pump.



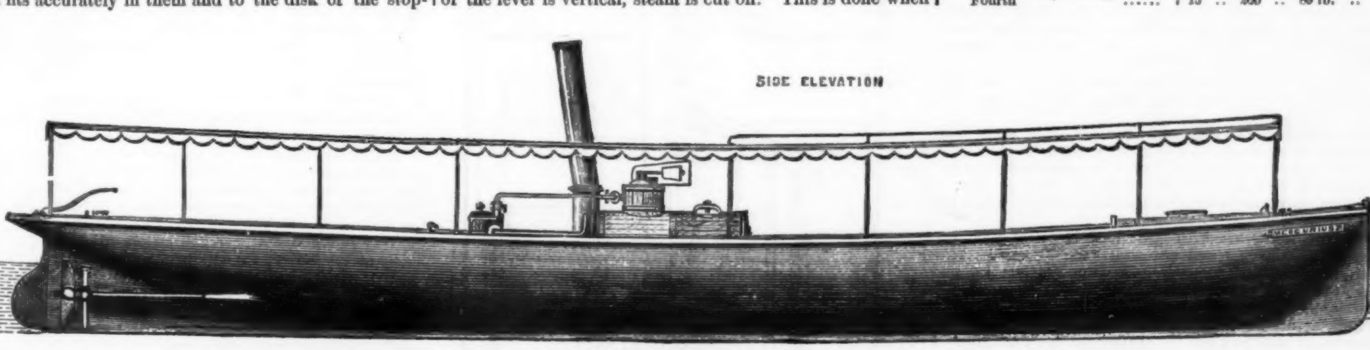
SECTION BETWEEN ENGINE AND BOILER

The boiler is cylindrical, of the marine, return tube type, constructed of Landore-Siemens steel. Those parts exposed to the action of the fire are of Lowmoor iron, and is intended for a working pressure of 100 lb. per square inch, and has been tested to 200 lb. It is fitted with two lever safety valves with flat seats and other requirements to pass the Dutch Government regulations. The trial of this boat, which took place on the Thames, gave the following results:—

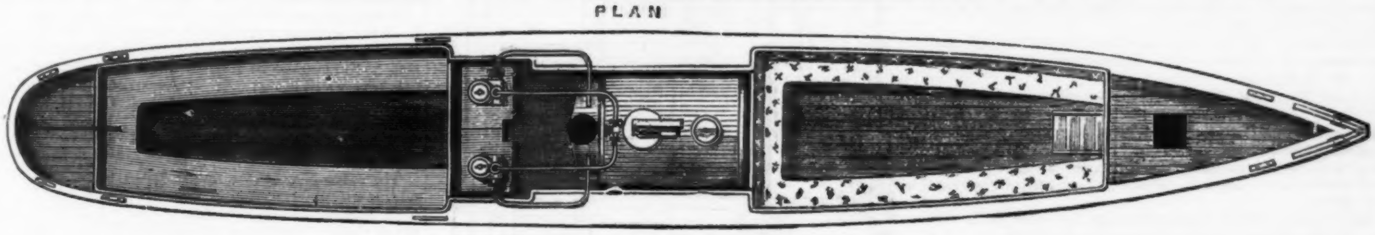
	Time. m. s.	Revols.	Steam.	Knots. Speed.
First run with the tide	4 41 ..	268 ..	90 lb. ..	12·81
Second " "	4 40 ..	262 ..	90 bl. ..	12·86
Third run against the tide...	7 58 ..	260 ..	88 lb. ..	7·53
Fourth " "	7 15 ..	260 ..	89 lb. ..	8·20

giving a mean speed of 10·375 knots, or twelve miles per hour, with 18 per cent. slip of screw. The speed required by contract was eleven and a half miles, but the above speed was easily maintained. Messrs. Edwards & Symes have paid much attention to lightness of draught, and among other light draught twin screws which have engaged them this year, are one for the War Department, 60 ft. long, built of wood, and one 112 ft. long, 20 ft. beam, for river service on the West Coast of Africa, and a paddle yacht in steel, 70 ft. long, with 2 ft. draught, for the Thames.—*The Engineer.*

SIDE ELEVATION



PLAN



TWIN SCREW STEAM LAUNCH.

THE STEAM YACHT "LADY FRANKLIN."

The Lady Franklin is 48 ft. 6 in. long, over all, and 9 ft. 6 in. beam; depth of hold, or distance from gunwale to top of keel, midway between bow and stern, is 4 ft.

Her machinery consists of a double engine, having cylinders 6½ in. in diameter by 8 in. stroke, driving a screw propeller 3½ ft. in diameter and 5 ft. pitch.

The steam ports are ½ in. wide by 6 in. long; the exhaust ports being 1 in. wide by 6 in. long. The maximum valve travel is 2 in. Steam and exhaust pipes are 2 in. in diameter; the exhaust nozzle was formerly 1½ in. in diameter, but has lately been reduced to 1 in.

The crank-shaft journals are 3 in number, each 2½ in. in diameter by 4 in. long; the line shaft is of the same diameter.

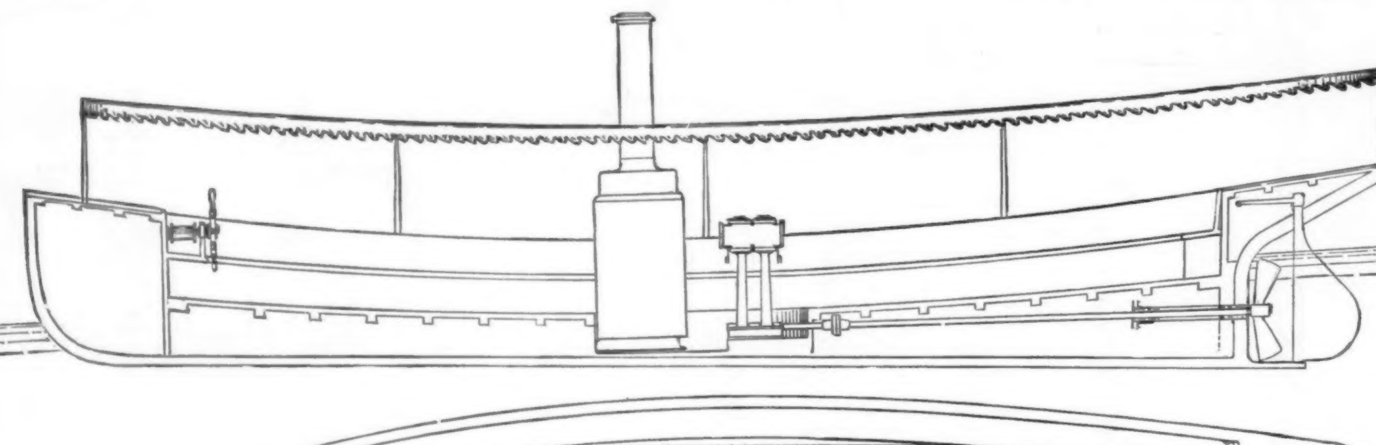
The boiler is of the vertical type, double riveted, and is constructed of ¼ in. iron, stamped T S., 60,000 lb.

Diameter of boiler is 38 in., and the height is 5 feet. It contains a firebox, 32 in. in diameter by 20 in. high, and 126 1½ in. tubes, 40 in. long.

There is a grate surface of 5½ square feet, and a total heating surface of 183 sq. ft.

The boiler is fed with a No. 2 "Friedman" injector of 90 gallons capacity, at 120 lb. steam pressure.

The delivery pipe of injector passes 5 or 6 times through a heater, 6 in. in diameter and 3½ ft. high; through which the exhaust steam passes.



THE STEAM YACHT "LADY FRANKLIN."

Everything considered, the performance of the Lady Franklin is very good.

With 125 to 140 lb. of steam, the valve travel being adjusted to cut off at about ½ stroke, the engines make from 350 to 360 revolutions per minute, a speed of 16 miles per hour can be kept up all day long; with an average consumption of about 200 lb. of good coal per hour.

Her usual travel per day, including stops, etc., is about 145 miles; during this time she consumes from 1,800 to 2,000 lb. of coal.

On or about the 10th of May, 1878, a run of 17 miles was made in one hour; the pressure of steam at beginning of run was 110 lb., and at end of run had been reduced only 10 lb.

The consumption of fuel, which was not of the best quality of bituminous coal, was about 200 lb., not over that.

This is, probably, the best run she has ever made with that pressure of steam and consumption of fuel.

She has often made a short run of 3 miles in 9 minutes, and another of 9 miles in 28 minutes. The former, it will be seen, is at the rate of 20 miles per hour, while the latter is a little less.

Draught of water aft with light load is about 4 ft., but this increases with the speed.

Usual load is about 100 passengers; the greatest number she has ever carried at one time was 176, not including her crew, of which there were 4 or 5.

The builder of her hull was Mr. Gardner B. Smith, her machinery was built by Chas. A. McDonald, both of Chicago.

She was launched the 19th day of May, 1875, and is now stationed at Clear Lake, Iowa.

We must thank Mr. Noyce Coats, her former owner, for his assistance in obtaining the dimensions, etc., also, his brother, Mr. J. S. Coats.

This is another case of vertical boiler performance that goes to show, when properly proportioned and constructed, is a simple, safe, and economical boiler; one that you have so frequently recommended to your readers for small yachts.

Nine-tenths of the deficient performance of this type of boiler is due either to those in charge of or those who proportion them.

In many cases, which was probably the case with the boiler of one of your correspondents some time ago, the proper proportions are overlooked.

Large, short tubes, with a powerful draught, may send half, and in some cases three-fourths, of the heat up the smoke-stack, without producing any useful effect whatever.

Again, the grate surface is so small that the combustion of fuel per sq. ft. of grate must go on so rapidly in order to make the required amount of steam that half the gases, etc., pass up through the tubes without being consumed.

On the other hand, many have a large grate surface. Here, with a proper draught, combustion may go on ever so perfect, but there is not sufficient heating surface in many cases to absorb the required amount of heat, and the surplus must pass up the stack.

However well a boiler may be proportioned and constructed, and economical in performance, unless it is under proper care and management, it will not and ought not to be efficient and satisfactory.

I do not mean to say that the performance of the boiler of the Lady Franklin is perfect; as to economy, it could be somewhat increased; but when we properly consider the condition under which the boiler was worked, I think its performance is as good as can be expected.

As to foaming, a great difficulty that your correspondent seems to encounter, the boiler of the Lady Franklin was never known to foam while under proper care, except when first used; this was due to grease and dirt, as your readers well know is always the case with new boilers.

It is well known that no established rules can be given concerning the proper proportions of grate surface, furnace, tubes, etc.

The only method of obtaining the information above is by carefully studying the proportions of boilers in use, and the conditions under which they are worked.

TWIN LOCOMOTIVE.

We give views of a twin locomotive constructed at the Schweizerischen Locomotiv und Maschinen-fabrik, Winterthur, for a tramway between Villa Real and Villa Regoa, in Portugal, this line being about 21 miles in length, and having gradients of 1 in 12½, as well as reverse curves of but 25 meters (82 ft.) radius. The line, we may add, is of 0·9 meter (35·43 in.) gauge, and is laid with rails of the ordinary tramway section. It was originally intended to work the line by mules, but this being found impracticable, the engine, of which we now give engravings, was constructed as an experiment, and it has, we understand, proved thoroughly successful.

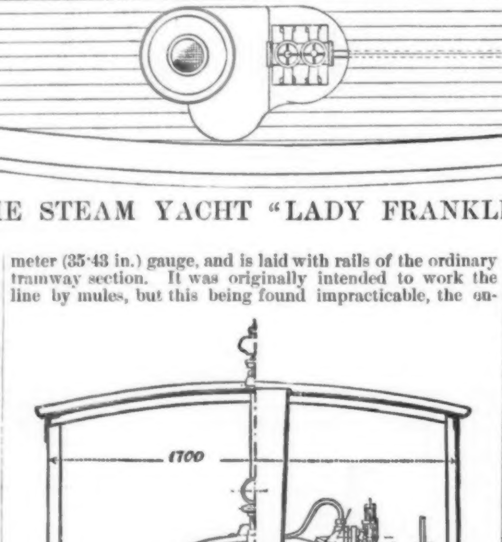


Fig. 2.

As will be seen from our illustrations, the engine, which was constructed from the designs of Mr. Charles Brown, the manager of the Schweizerischen Locomotiv und Maschinen-fabrik, includes some very novel features. It consists practically of two six wheeled tank engines placed at a distance apart of 38 ft. from center to center of the middle axles, and having slung between them a strong iron bridge or frame on which the load to be carried can be placed. This frame consists of two substantial plate girders, 17·7 in. deep, and properly braced together, these girders supporting between the engines a platform, 26 ft. 7½ in. long by 5 ft. 10⅝ in. wide, on which a load of 15 tons can be carried. The two girders are connected at each end by a crossbar fitted with cupped bearings for the spherical ends of a pair of suspending links, these links extending upward to spherical bearings at the tops of the side tanks of the engines (see transverse section, Fig. 2).

The platform is 2 ft. 2·4 in. above the rail level, and the links by which it is suspended at the ends (and which are each fitted with the means of adjustment for length) are about 4 ft. 4 in. long, so that the engines are left very free to adjust themselves to curves, while any tendency of the platform to lateral oscillation is prevented by a pin which passes through the center of each end crossbar of the bridge and a suitable frame on the tank of the corresponding engine. It is, of course, through these pins that the hauling or pushing power of the engines is also transmitted.

The two engines connected by the bridge are of identical dimensions, and they are of a type to which we have before alluded in this journal, as having been very successfully introduced by Mr. Brown. Each engine has cylinders 8·66 in. in diameter and 12·8 in. stroke, while the six coupled wheels are 23·62 in. in diameter, the tractive force of each engine thus being $\frac{8 \cdot 66^2 \times 12 \cdot 8}{23 \cdot 62} = 40 \cdot 6$ lb. for each pound of effective pressure per square inch in the pistons. With a mean effective pressure of 100 lb. per square inch on the pistons, the two engines would thus be capable of exerting a tractive force of $40 \cdot 6 \times 100 \times 2 = 8{,}120$ lb. On the other hand, the weight of each engine empty is 7 tons, or about 8½ tons in working order, while the bridge weighs 3·3 tons, and carries, as we have said, a load of 15 tons, making the total weight loaded $(2 \times 8 \cdot 5) + 3 \cdot 3 + 15 = 35 \cdot 3$ tons. This load, of course, is all carried by the coupled wheels, so that there is ample weight for adhesion even with a bad state of the rails.

On such a tramway as that on which the engine has to work the resistances are probably not much less than 20 lb. per ton, so that, including the effect of gravity, the total resistances for the above mentioned load on the gradients of 1 in 12½ are probably nearly 7,000 lb. This, however, is very much within the full power of the engine, particularly as the boilers are capable of carrying a pressure of 200 lb. per square inch, and the mean effective pressure in the cylinders might thus be considerably higher than we have assumed above. As a matter of fact we believe that one engine is found almost sufficient to take the load up the steep gradients just mentioned.

Referring now to Fig. 1, it will be seen that the engines have the cylinders arranged completely above the level of the wheels, the power being transmitted from the piston rods to the connected rods through the intervention of rocking levers. This system of construction has been extensively adopted by Mr. Brown, and the results have been found very satisfactory, the rocking beams being provided with a very large bearing surface at their centers of oscillation, and the wear at this point being found inappreciable.

The valve gear is also of the type designed by Mr. Brown, which we illustrated and described when dealing with the tank engine to which reference has just been made, each valve spindle receiving its motion from a lever, of which the lower end is coupled to the connecting rod, while the upper end is guided in a straight line by an arrangement of parallel motion. The links constituting the parallel motion oscillate in centers carried by a crossbar fixed on the end of the weighbar, the effect being that when this crossbar is horizontal, the upper end of the lever to which the valve spindle is coupled moves in a vertical line. When, however, the weighbar is partially turned by the reversing lever, so as to bring the crossbar into an inclined position, the upper end of the lever coupled to the valve spindle is caused to move in an oblique line, and the travel of the valve is hence increased just as it is by putting an ordinary link motion into full gear. The direction in which the weighbar is turned determines as usual whether the motion im-

Fig. 1.—TWIN LOCOMOTIVES WITH FREIGHT PLATFORM BETWEEN. DESIGNED BY CHARLES BROWN.

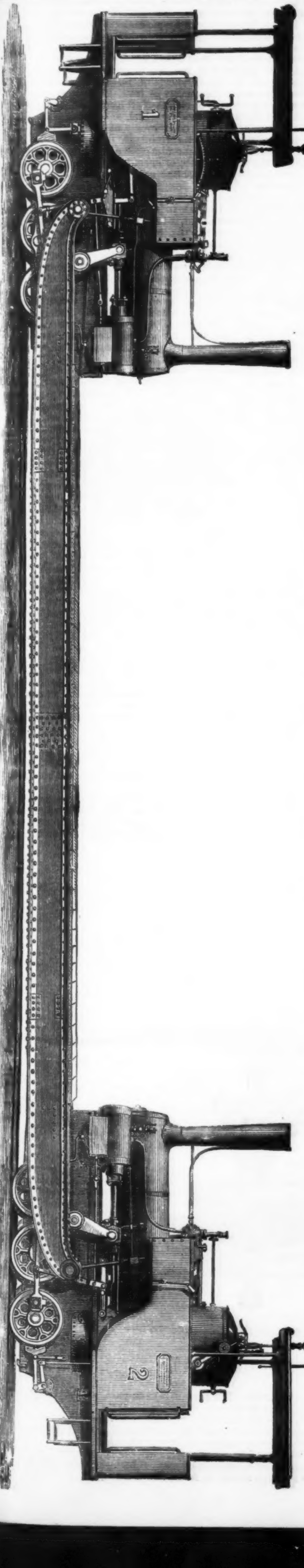


FIG. 1.—TWIN LOCOMOTIVES WITH FREIGHT PLATFORM BETWEEN. DESIGNED BY CHARLES BROWN.

parted to the valve is that for the forward or backward movement of the engine.

The valves are arranged below the cylinders, and kept up to their faces by springs at the back.

The engine frames are very deep, and constitute also the sides of the tanks. The axle box guides on opposite sides of each engine are connected by transverse stays, as shown, and the axle boxes themselves are similarly connected, provision being made for insuring the fair bearing of the axle boxes on the axles, notwithstanding any unequal play of the springs on the two sides of the engine. Each engine is carried on three points, there being a transverse spring at the leading end and a spring at each side having its ends bearing on the trailing and middle axle boxes respectively. The axles are placed at equal distances of 2 ft. 2·6 in. apart, the wheel base of each engine being thus 4 ft. 5·2 in. only, while the total wheel base of the pair of engines, with their connecting bridge, is 42 ft. 6 in.

The construction of the boiler is shown by Fig. 2. The firebox shell is cylindrical and is carried a considerable height above the barrel of the boiler, the crown of the firebox being about level with the top of the barrel, so that there is no steam space in the latter. The lowest water level is taken at 4 in. above the crown of the firebox, and the highest level at 14 in. above that crown, a working range of level of 10 in. being thus provided for, a great convenience in working on a hilly line. The diameter of the firebox shell is 2 ft. 3·6 in., and that of the barrel (inside the smallest plate) 1 ft. 11·6 in., the barrel being inclined upward toward the firebox casing, so as to allow of the escape of steam into the latter. The steam is collected by a series of finely perforated pipes, radiating from a central casting at the top of the firebox casing, a steam pipe communicating with the chamber of this casting passing out through a stuffing-box at the front of the firebox casing to an external regulator valve as shown.

The firebox is cylindrical at the lower part, the upper part, however, being flattened at the front side to form the tube-plate. The crown is slightly domed and is stayed directly to the crown of the firebox casing. The tubes are 70 in number, and are 6 ft. 3 in. long by 1½ in. outside, and 1·34 in. inside diameter. The chimney is 7·9 in. in diameter at the smallest part, and the blast nozzle has a

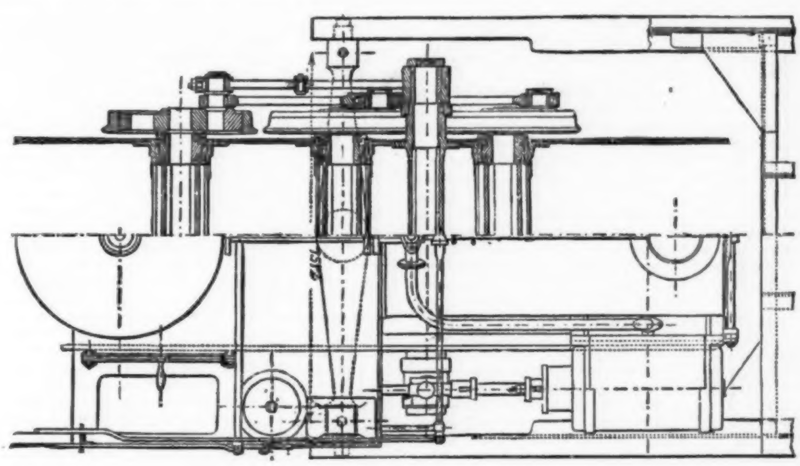


FIG. 3.

diameter of 2·17 in., or an area equal to one-sixteenth that of each piston. The chief proportions of the boiler are as follows:

	Sq. ft.
Heating surface: Firebox	20·3
Tubes (external)	193·7
Total	214·0
Firegrate area	3·98
Flue area through tubes	0·79
Least sectional area of chimney	0·34
Ratio of grate to heating surface	1 : 54
" firebox surface to tube surface	1 : 9·54
" flue area through tubes to grate area	1 : 5·04
" least sectional area of chimney to grate area	1 : 11·7

We may add that the type of boiler we have been describing is one which Mr. Brown has extensively used for tramway engines and tank locomotives of small power, and we understand that the results obtained with it have been very satisfactory.

In addition to the ordinary brake blocks applied to the trailing wheels, the twin engines forming the subject of the present notice are fitted with a counter pressure air brake arranged as follows: At the bottom of the blast pipe a double-faced valve is provided, this valve being so arranged that it can be raised by the lever shown, it, when so raised, closing the bottom of the blast pipe, and placing the exhaust passages of the cylinders in free communication with the air. To obtain the desired retardation, the engine is reversed and this valve opened, when the cylinders act as air pumps drawing in air through the opening uncovered by the valve just mentioned and forcing it back into the steam pipes. Thence the compressed air would, if the regulator valve was opened, pass into the boiler, but the regulator is made so that the valve can be held close down to its seat, and the escape of the compressed air is allowed to take place into the air through a cock specially provided for that purpose as shown, the cock enabling the amount of the counter pressure to be regulated as desired. Of the remaining features of these engines, it will be unnecessary that we should give any detailed description, and in conclusion we need only remark that the whole arrangement is well carried out, and that it forms an example of special locomotive design of very considerable interest.—*Engineering.*

PUMPING GOLD.

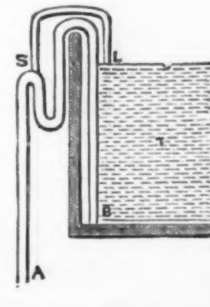
AT the Union Iron Works in San Francisco a large Morcan gravel pump is now being built, which will be shipped to mines near Barbacoas, in South America, for working the auriferous gravel deposits, which are known to be very rich, in certain rivers there. This machine has a suction pipe 14 inches in diameter, and will be driven by an engine of 100-horse power. The company claims, on the basis of working tests in this city, that such a pump has a capacity of raising 32,400 cubic yards in twenty-four hours, one-half of which may be solid matter, cobble stones, gravel, sand, etc., if the bulk of the suction pipe be kept near the materials to be raised. Mr. Morcan's pump differs from other centrifugal pumps, in that it has no valves, contractions, nor obstructions of any kind, giving a continuous flow, free from stoppages, heating, or other cause of trouble. The company proposing to operate in South American rivers has examined many dredging machines in this country and abroad, and has finally selected the Morcan pump, as offering better results than any other. A company has recently been incorporated in this State for working the bed and bars of Feather River, at Oroville, with similar pumps.—*Alta.*

NEW AUTOMATIC SIPHON.

By Dr. WILLIAM TAYLOR.*

THIS is an apparatus designed to serve as an overflow pipe to tanks or other vessels not already fitted with means to that end, and without in any way altering these vessels. It is specially applicable to tanks with a fluctuating supply of water, but in which the water must be maintained at a constant level. As its name implies, it is self-acting, and while at once carrying off any sudden influx of water, it will not bring the level below a certain fixed line. The excess of water is carried from the bottom of the tank. Into the tank, T, is passed the waste pipe, A B, of a diameter greater than the feed to the tank. This waste pipe is bent into the form shown, with the shoulder, S, about half an inch lower than the level of water required in the tank. In the upper surface of this shoulder, at S, a small hole is made, over which a small tube is fixed. This small tube, S L, is then led over the side of the tank to the constant level, L, required.

When this waste pipe is put into action as a siphon, it rapidly carries off the water to the level, L. When it reaches this, air is admitted by the small pipe through the orifice at L, and the waste pipe ceases to be a perfect siphon. If, now, a small stream of water flows into the tank, the same quantity passes through the partial siphon, A B; but should a rush of water into the tank take place, bringing the water above the level, L, the waste pipe is at once converted into a true siphon, and rapidly brings the level back again.



In this sketch, the pipes have been drawn projecting from the sides of the tank, but, of course, in practice, these pipes are laid close to the sides of the tank.

* Exhibited before the Edinburgh Photographic Society.

AN EXHIBITION OF WALL-PAPERS.

AN evening entertainment of a novel and interesting character was given in Chicago to a few invited guests at the rooms of John J. McGrath, in that city. It was the first of a series to be continued through the winter and spring, the remainder of which will doubtless be thrown open to the public. The object of the exhibition was to show the progress made in the designing of wall-papers of late years, compositions and arrangements of papers for decorative purposes, and combinations of printed wall-papers with painting by hand. The last of these is a process of recent introduction. Paintings are executed on plain wall-papers after hanging, or on diapered patterns in color or gold used as backgrounds, or printed designs are varied by handwork to harmonize with surrounding details, either by painting out or filling in. Sometimes two printed patterns are blended into one, as was shown on a folding screen. Common canvas printed in bold chintz patterns is toned down by glazes of oil color and used as a background for figure painting. A French example of this was exhibited. Wall-papers with gold grounds are painted with oil colors, those

with colored grounds in distemper, or the same colors as are used by the print work.

A large number of papers and samples were exhibited which had been collected by Mr. Joseph Twyman during a recent visit to France and England. Among these was Walter Crane's new peacock frieze, designed for Jeffrey, especially to be exhibited at the late Paris Exhibition, just as his Marguerite paper was issued by the same house for the Centennial Exhibition—though seen then by few, for it was hidden away in a lofty gallery. The frieze paper of this last-mentioned set, commonly known as the Alcestis frieze—as it portrays Queen Alcestis and the womanly virtues which she possessed, as described in Chaucer's "Legende of Gode Women"—was exhibited in a frame. It contains, besides the queen, her guardian angel and four female figures typical of her virtues. The peacock frieze is made in heavy, embossed paper intended to imitate leather; several shades of bronze are used on it besides colors. The peacocks, with outspread tail feathers, stand, I may say, in front elevation. Between them are represented, as described by Mr. Crane, the winged genii of time, with sickles in outstretched hands, mounted on harvest cars. The full set of papers, of which this frieze is only a part, received a gold medal at the Paris Exhibition. Another frame contained a frieze pattern by J. Moyr Smith, representing the seasons, by figures of men plowing, sowing, reaping, and thrashing. Another frieze from De Fossée, of Paris, was exhibited. It is twenty-four inches wide, and represents the Triumph of Ceres. The pattern is thirteen and one-half feet long without repetition, and it required one hundred and thirty-two blocks to produce it. This is probably the most costly piece of hand printing ever attempted. A frieze by Le Cerf of Paris was sixty-two feet long and twenty-eight inches wide. It was mounted on canvas and hung on one of the side walls in a heavy black frame. It contained twelve different figures on gold grounds, being flat, conventional drawings of men in various occupations of life. Each figure was divided from the next by a diaper pattern on gold ground. The whole was inclosed with horizontal and vertical borders of Gothic pattern. This is the only set of the frieze that has been brought to America.

Mr. McGrath exhibited a number of his own private patterns, many of them specially designed for him. He is one of the few dealers who have employed American artists to make special designs for wall-papers.

The outer walls of the entire room were draped from cornice to floor with about three hundred patterns of paper, representing the different periods of decoration from the thirteenth century to the present time.

English designers were represented by J. Moyr Smith, B. J. Talbert, Dr. Dresser, Walter Crane, William Morris, Wilberforce, R. Bennett, Milford Warner, Henri, and the late E. W. Pugin and Owen Jones; Americans, by Deisner, R. Sturgis, Wight, and Twyman; while French manufacturers were represented by Ballin, Hoch Frères, Gillow et Fils, Bézault et Patti, and De Fossée of Paris; English manufacturers were represented by Jeffrey, Carlisle & Clegg, Scott, Cuthbertson & Co., and Tolman of London, Trumbull & Sons of Leeds, Potter & Darwin, Lancaster, and Wylie & Lochead of Glasgow. The leading American houses of Philadelphia, New York, and Brooklyn were also represented.

There were some examples of papers, dadoes, and friezes called in England the "Adam style" of decoration; very Italian in feeling, with just a touch of the English pervading both coloring and design. The style gets its name from the brothers Robert and James Adam, celebrated architects of the eighteenth century. It will be remembered that some mention of the works of these men was made in the papers on "Decorative Fine Art Work" at the Philadelphia Exhibition of 1876, Messrs. Wright & Mansfield, of London, having exhibited some paneled decoration in that style, which is just now the fashion in London. The only examples of it which have been produced were brought over by Mr. Twyman.

The leading feature of the exhibition was a series of screens hinged together, three in a set, representing the sides of a room. Four suggestions of rooms were thus presented with two sets of screens, they being covered on both sides. The first showed a drawing-room treated with combinations of papers, American and English, and had painting on paper grounds. The main wall-paper of this room consisted of a well-drawn holly in gold and color on a background representing mistletoe on a black ground. This was separated by an ebonized picture rod from a very broad frieze, consisting of a black ground with branches of mistletoe and holly painted in oil colors from designs of Mr. Twyman. The frieze was broken up at distances of about four feet by panels having in them the figures taken from Walter Crane's Alcestis frieze on dull red ground. A panel representing the space over a mantel-piece contained a painting in oil colors on figured canvas, representing a *grande dame* of France in early eighteenth-century costume; surrounding the painting was a border of heavy Utrecht velvet paper, with ebonized mouldings between it and the picture. A dado paper, separated from the main wall-paper by an ebonized chair moulding, was in myrtle greens and gold, of English make. Above the mantel panel was a black panel, with ebonized shelf between, the background being left plain to afford relief to plaques or pottery. Gilt sconces were placed on each side of the mantel panel. The apartment had a dull maroon India rug on the floor, and contained a few ebonized chairs and a spinning wheel. The second apartment represented decoration suitable for a dining-room. A wall-paper eight feet high from the base moulding contained straggling branches of orange-tree in six different colors of flocks on a greenish metal ground. Above it was a twenty-inch band of maroon velvet paper hung with Delft plates and some hand-painted ones by American women. The frieze above this was thirty inches wide, with gold ground, having painted on it a bold growth of lilies springing up at irregular heights. A door was represented, and over it a shelf containing some blue Flemish stone-ware. The side casings of the door ran up to the ceiling. The first panel over the door was plain maroon velvet. The second panel in line with the frieze consisted of a branch and bird painted in oil, with Japanese contempt for symmetry, upon a gold paper ground. This was designed by Mr. Twyman. The third room represented was suitable for a library. The lower paper was of Japanese character, with vines in gold ground. It was eight feet six inches high, and intended to form a proper background for bookcases. Above this was a thirty-inch band of gold mosaic pattern, forming an excellent background for some busts which were placed against it on brackets. Above it was an eighteen-inch frieze of the same tones of color as the main paper. The fourth apartment suggested a reception room in the Henri IV. style. It was entirely decorated with imported French papers, having panel treatment throughout. But the panelings were formed by interlacing flat bands of ebonized wood, which removed all suggestion of constructive work, bringing out the full decorative or pictorial effect of the very rich papers employed. The styles were embossed Utrecht velvet, very wide; the mouldings around the main panels were double rows, with inlays between of eighteenth-century design; the panels were of French tapestry paper, in dull browns and reds with gold thread on deep russet ground. Draped across one end of the room was a piece of Henri IV. tapestry. The floor had an old Persian rug. Paintings hung on walls had gold frames. The furniture was ebonized, with rich tapestry coverings. All the papers in this room were made by Bézault, of Paris.

With such an exhibition as this before us it needs but little reflection to realize what an immense advance has taken place in the designing and manufacture of wall-papers within the last five years. It is not long since a few enthusiastic architects would clutch to their bosoms any samples of artistic papers that might come into their hands, and hoard them up as precious things. To be able now to go into a store and select from three or four hundred patterns, all designed by the first artists of England, France, and America, must be regarded by every lover of the beautiful with genuine satisfaction. But to visit a private exhibition of three hundred wall-papers, and not see a single pattern which is bad in design, may be safely said to be one of those things we have scarcely dreamed of.—W.—*Am. Architect.*

THIN PLATES OF METAL.

By Professor T. EGLESTON, Ph.D., School of Mines, Columbia College, New York City.*

THE importance of having perfectly pure metals has led me to present to the Institute a record of some of the trials that have been made to obtain these metals, and also to show one of the largest specimens of extremely thin metal which has ever been made. The malleability of metals varies generally directly with their purity, and hence it is only with very pure metals that thin sheets can be obtained. The competition among different manufacturers has been so great at times as to lead to expensive and apparently useless experiments in obtaining in the first instance very thin sheets, and afterwards very large and thin sheets of metal, apparently with no other purpose than that of being able to say that they had produced the thinnest or the largest thin sheet that had ever been made. These experiments were at first confined exclusively to iron, their object being to show the great dexterity of manipulation, as well as the purity of the metals manufactured. They have since been extended to almost all metals by electrical action, and have gone far beyond the limits of what was possible with purely mechanical means. The processes which have been used are rolling, hammering, electrical deposition in a vacuum, and lastly, electrical deposition on plates, easily soluble in acids. The first and last of these methods have been known and practiced for a very long time, having been used to make thin sheets of almost all the metals. The other is of quite recent application.

In the iron manufacture, the strife to produce these thin sheets was commenced in the year 1865, by the Sligo Ironworks writing to a firm in Birmingham, England, on a sheet of iron containing 270 square centimeters, and weighing only 4·469 grammes. For some time this was considered to be the thinnest sheet iron that could be made. T. W. Booker & Co., of Cardiff, England, however, produced, a few months afterwards, a sheet of the same size, weighing only 4·015 grammes. This was succeeded by one rolled by Neville & Everitt, of Llanelly, weighing only 3·174 grammes. This was followed by one from Hallam, of Swansea, which was 283 square centimeters in size, and weighed but 2·979 grammes; and this by one rolled by R. Williams & Co., of West Bromwich, was 445 square centimeters, and weighed 3·173 grammes. This was succeeded by the Hope Society of Tipton, which produced one measuring 1,425 square centimeters, and weighing 11·529 grammes. Finally, the Upper Forest Tin Works, near Swansea, produced a sheet measuring 155 square centimeters, and weighing 1·296 grammes, which required 1,888 together to make one decimeter in thickness. The thinnest tissue paper is about four times as thick as this sheet of iron. Recently Professor Wright, of New Haven, has produced by means of electrical discharge, perfectly transparent films of iron and of magnetic oxide, but only over a very small surface. No application has ever been found for such a thin metal as this, but the skill necessary to produce it has led to great improvements in the machinery by which sheets of metal are rolled, and a decided advance in the quality of iron. The next step was to produce thin sheets of metals of all kinds, which led Prof. Wright* to invent a method by which he could produce films of almost any degree of transparency of any metal, depositing them with sufficient certainty and accuracy to make either transparent or opaque films. The opaque ones he has applied to the manufacture of speculum mirrors, depositing on glass films of gold, 0·000183 mm. thick, and of platinum, 0·000174 mm.

The special object, however, which I have in making this communication, is to show to the members of the Institute a film of transparent gold, which is one of the largest, and at the same time one of the thinnest, ever produced. It is 5·7 millimeters square, and by transmitted light is perfectly transparent, and of a pale yellow color, except in spots where the film has been purposely doubled, where it is very light green. This film was prepared by Mr. E. A. Outerbridge, of the United States Mint, in Philadelphia. It is estimated that its thickness is not more than 0·0001 mm. to 0·00015 mm., and it is 15,000 times thinner than ordinary printing paper; the difficulty of asserting the thickness is owing to the fact that its weight does not appreciably affect the balance. It is not more than $\frac{1}{100}$ part of a single undulation of a green ray of light. It is so extremely transparent that it does not reflect the full golden color, partly because the gold still retains a trace of copper, which gives it a reddish tinge. The method of preparing the plates was by depositing the gold from a galvanic battery on a sheet of thin copper, rolled down to a thickness of 0·005 mm. This was then cleaned and carefully burnished, and placed in the bath; when the gold had been deposited it was removed, and immersed in weak nitric acid for several days, dissolving out in this way almost the whole of the copper, while the gold floated on the surface; it was then floated upon glass, and placed within two plates. In order to ascertain the weight of previous films which were thicker, the copper was weighed before immersion in the battery, then taken out and reweighed, the difference giving the weight in gold, the calculation being based on the weight of a cubic decimeter of pure gold. It is found that in this way gold may be spread over a space many times larger than the thinnest gold that can be prepared by beating. It is remarkable on this specimen, that in rolling the copper, imperfections in the rolls produced very slight irregularities in the copper film. These are all reproduced in the shape of fine striæ on the gold, which was floated between the glass, probably owing to the fact that the copper was more compressed in the direction of these lines, and had thus been a better conductor, so that the gold was deposited there more rapidly than over the rest of the surface. When the plate is of appreciable thickness, these irregularities can be burnished out. With a plate so thin as this, nothing can be done. It cannot be handled or touched, except floating on water, and then only with a fine camel's hair pencil. It is so perfectly transparent that the finest print can be seen through it without the least difficulty.

THE SMITH-ODLING MINER'S LAMP.

A GOOD miner's lamp must necessarily possess the following qualities:

1. The flame must be surrounded by some substance sufficient in mass to absorb the heat and reduce the temperature of the flame, so as to render it unable to ignite explosive gases. At the same time the substance must permit a sufficient number of luminous rays to pass, as the lamp would otherwise be useless.

2. The oil must be completely consumed.

3. The lamp must be constructed so that it cannot be opened by the miner under any circumstances.

The first two requirements are easily complied with, but the last point has caused many difficulties already. No mat-

IMPROVED MINER'S SAFETY LAMP.

* Read at the Chattanooga meeting of the American Institute of Mining Engineers, 1878.

* Silliman's Journal, 3d Series, vols. 13 and 14.

ter how ingenious the devices may be which have been invented to prevent the miners from gaining access to the flame, they always find some way to outwit all the precautionary measures of their superiors.

Among one of the best solutions of the problem is the lamp used in the coal mines of St. Etienne. It is held together by a bolt placed in the interior and out of reach when in position. It can, however, be removed by means of a powerful electro-magnet.

The lamp illustrated by the accompanying engraving is similar in construction. The electro-magnet has, however, been dispensed with. The bolt holding the different portions of the lamp together cannot be removed except by the aid of a hydraulic press. Ordinarily it is held in position by a powerful spring. The construction is easily understood from the illustration. The lamp may be opened, cleaned, filled, lit, and closed again in a comparatively very short time. Its weight does not exceed that of the lamps ordinarily used.

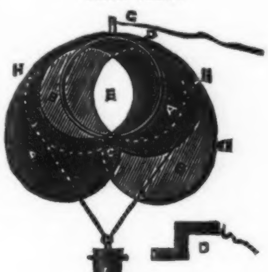
The lamp is the invention of Mr. Smith, and is manufactured under a license from the same by Mr. Odling, of Nottingham.—*Revue Industrielle.*

DUPLEX DROP SHUTTER.

By W. BEDFORD.*

So many ingenious plans have been devised for giving rapid exposures that I feel that some apology is needed for bringing before you this evening a contrivance of my own, which, however, if not superior in principle to any hitherto introduced, has the merit of simplicity, and I think it will also be found to do its work efficiently.

BACK VIEW.



A A. B B. Two similar metal disks pivoted at C. D. Ring adapter fitted to mount of lens. E. Center of lens. F. Weight attached by silk cord to each disk. G. Trigger with cord attached, fitting into notches. H. When the exposure is completed, the stop at I comes in contact with an overhanging hook, near the trigger, which also serves to keep the disks in contact.

It is essentially constructed of two heart-shaped metal plates revolving on one axis, which is attached to the lower part of the mount of the lens. These two plates, when released by the trigger, have a reciprocal motion imparted to them by means of the weight which hangs suspended from the upper part of each. The apertures in each plate are thus simultaneously brought in front of the lens, and the exposure rapidly effected. You will observe that the exposure commences and terminates at the lower side of the center of the lens, so that the foreground will get slightly more light than the upper portions of the picture, an advantage which will be readily appreciated by most photographers. It will be seen that the exposure may be easily accelerated by the addition of extra weights. I have not yet had an opportunity of testing its rapidity, but I purpose doing so by photographing a pendulum of suitable length oscillating within a given arc. It will then be only necessary to read off from the resulting negative the number of degrees traversed by the pendulum during the exposure, to arrive, by a simple calculation, at its duration. If any member present can propose any more trustworthy test, I shall be glad to have the advantage of his suggestion.

MANUFACTURE OF SUGAR.

IN the well-known process of Scheibler, the sugar contained in the molasses and sirups is gained in solid form as a tribasic saccharate of lime, from which again a solution of monobasic saccharate is obtained. In order to separate the sugar from these saccharates, they are generally decomposed by carbonic acid, or they are mixed with a fresh lot of cane juice. In the former case the lime combines with the carbonic acid and precipitates, leaving the sugar in solution; in the latter case it combines with some organic acids contained in the juice and is likewise precipitated. The carbonic acid process is hardly applicable profitably on a large scale, and the other method cannot be employed where fresh juice is not available. Mr. Drevermann, of Berlin, suggests the following improvement. If a concentrated solution of sulphate of magnesium is mixed with a solution of saccharate, holding also a quantity of the latter in suspension, hydrated magnesia and sulphate of calcium are formed. The latter, at the same time, combines with any coloring matter that might yet be present, so that a very light and clear solution of pure sugar remains. It is advisable to use a small excess of lime to render the liquid slightly alkaline. The saccharate of lime prepared according to Scheibler's method contains yet some alcohol, and it is best not to remove the latter until the reaction between the saccharate and the sulphate has taken place, as even the smallest trace of alcohol renders the gypsum perfectly insoluble. Should there be some slight traces of lime left in the saccharine solution they may be removed by means of carbonic acid.

The precipitate formed is highly valuable as a fertilizer, especially for soils poor in magnesia. It may also be used to improve the atmosphere of stables, closets, etc., as it absorbs large quantities of ammonia. The same process may be employed when strontia or baryta has been employed instead of lime.—*Chemiker Zeitung.*

THE WAY IT GOES.—In Jones County, Iowa, two farmers had a quarrel about 14 fence rails, alleged to be worth $1·40 They hired two lawyers and went to law, hammer and tongs. After a long contest the plaintiff got a verdict of one cent, the cost to the county was $60, and the lawyers had pocketed $324. The farmers then elected the lawyers to the Legislature.

* Read before the Photographic Society of Great Britain.

THE AMMONIA-SODA PROCESS.

THE first serious rivalry with which the time-honored process of Leblanc for soda manufacture has been threatened during the nearly three-quarters of a century in which it has enjoyed an undisturbed monopoly of the leading chemical manufacture of the world, promises to come from the so-called ammonia process, of which occasional notices have appeared in our pages, and which, within the past few years, has made such remarkable progress in the hands of Solvay as to have attracted an unusual share of attention.

The credit of having been the first to recognize the eminent merits of this simple and scientific process, and of having been the first to appreciate the important influence which its certain development must sooner or later exercise upon the future of the soda manufacture, must be accorded to Professors A. Hofman and Rudolph Wagner, who, independently of each other, in their reports on the Chemical Industries at the Vienna Exhibition of 1873, expressed themselves in terms of most cordial indorsement respecting its value. Hofman, indeed, even at that early date, ventured the bold prediction —which, in the light of subsequent events, reflects equal credit upon his scientific attainments and the keenness of his practical insight—that the new process was destined at no very distant period to entirely supplant that of Leblanc. When the fact is considered that at the Vienna Exhibition for the first time commercial samples of the new product were exhibited in any noticeable quantity, the hazardous nature of such a prediction respecting an infant industry, and especially when the prodigious proportions of the old established industry are considered, will be apparent. With these preliminary remarks, we invite the attention of our readers to a brief history of the growth of the ammonia-soda process.

The general chemical principles upon which the ammonia process is based are not, comparatively speaking, new, but on the contrary, have been known for years, and repeated efforts had been made by chemists and manufacturers to turn their knowledge of these facts to practical account; but so unsatisfactory were the experimental trials that had from time to time been made, that the opinion prevailed that it was not susceptible of realizing practical commercial requirements. It is not surprising, therefore, that the insignificant exhibit of Solvay & Co., of ammonia-soda, at the Paris Exhibition in 1867, should have attracted little or no notice. The Vienna Exhibition, and the outspoken indorsements of Wagner and Hofman, however, set at rest all doubts as to the praticability of the process on the commercial scale, for there Solvay showed that he had succeeded in developing the process to the rank of a successful and growing industry, employing a large force of workmen, and turning out a yearly product of 90,000 cwt. of soda. The progress of this industry since the period of the Vienna Exhibition has been rapid and substantial, as will shortly appear.

The chemistry of the ammonia-soda process is exceedingly simple. If a concentrated solution of common salt (sodium chloride) be mingled with a similar solution of ammonium bicarbonate, a double decomposition ensues, the resulting products of the reaction being sodium bicarbonate and ammonium chloride. This sodium bicarbonate separates from the liquid, and is easily converted into the simple carbonate, which is the soda of commerce, by the application of heat, when one equivalent of the carbonic acid is driven off.

As with every commercial operation of magnitude, much of the success of this process depends upon the skill with which the by-products are worked over, and in the operation we are considering, the ammonium chloride that is formed is treated with milk of lime (or some equivalent alkaline substance), and the ammonia gas liberated is again condensed, and with the surplus carbonic acid drawn off from the bicarbonate of soda, as above described, the bicarbonate of ammonia is regenerated, to be utilized in a subsequent operation. The resulting waste product, where caustic lime has been used to regain the ammonia, is the chloride of calcium, but this source of loss has of late been avoided by the substitution of magnesia for the lime, for the chloride of magnesium by simple heating is converted again into magnesia to serve in subsequent operations.

The reactions above described are exceedingly simple, and may be reproduced without difficulty by any one having the simplest laboratory conveniences at hand; but their industrial utilization has only been accomplished at the cost of much time and many failures.

The earliest record of the ammonia process appears in an English patent granted in the year 1838 to Messrs. Dyar & Hemming, who seem to have been among the first to appreciate its technical importance. Following very closely upon this, in point of time, appears the French patent of Delauney, who, from the circumstances of his specifications being an almost literal translation of that of Dyar & Hemming, is now generally assumed to have been selected by these inventors to represent their interests in France. In these specifications the chemical details of the ammonia process were fully and correctly described, though as may be supposed, from the commercial failure of their operations, the mechanical features were only imperfectly worked out. Before Solvay's time, many of the leading chemical manufacturers and experts of England, France and Germany, appear to have made earnest efforts to place the ammonia process upon its feet (in a commercial sense), among whom may be named Muspratt, Schlösing, Rolland, Gossage, Deacon, and a company had even erected in Cheshire a large works for soda manufacture on Dyar & Hemming's patent. Deacon, whose name will be familiar to our readers as the originator of a highly successful process of making chlorine, made many trials at solving the problem with a process of his own, and with that of Gossage. Another establishment was built at Leeds, in England, and Muspratt, whose name is closely associated with the introduction and development of the soda industry of that country, made, about the year 1855, many and costly experiments with the ammonia process at his works in Newton, Lancashire. In 1842, an earnest effort was made to introduce the process at an establishment in Vilvorde, in Belgium; the patented process of Turck was likewise essayed in 1854 by the Société des Salines, at Sommervilliers, near Nancy, in France; and Schlösing and Rolland founded ammonia-soda works at Puteaux in 1855, which were, however, abandoned in 1858.

From this brief narrative of the attempts to introduce the ammonia process as a successful competitor with that of Leblanc, all of which resulted in failure more or less complete and disastrous, it does not appear that either talent or capital were wanting to insure success; and the cause of the repeated failures that attended these pioneer efforts, must be ascribed partly to the numerous practical difficulties surrounding the new process, and the crudity of the apparatus employed, but mainly, no doubt, to the obstacles opposed by the enormous development and commercial advantages enjoyed by the already established Leblanc soda works.

The first record that appears of Solvay's identification with the manufacture which has made him famous, as the first to succeed where so many had essayed only to fail, appears to date from 1861, in which year he obtained patents based upon substantially the same chemical machines as those of Dyar & Hemming before referred to.

In 1863, he was granted patents upon his first apparatus, with which he obtained such satisfactory results that he was encouraged to abandon an experimental works he had constructed near Brussels, and to erect an establishment of considerable magnitude at Couillet, in Belgium, which has since acquired the distinction of having been the pioneer establishment of a very successful industry. The success of Solvay, however, was only achieved after many reverses and many modifications of his apparatus and plant. A special diploma of honor, at Vienna, 1873, was the first public recognition that he received of the value of the work that he had succeeded in accomplishing, and from that time (1873) until the present the progress of the ammonia-soda manufacture has been very rapid and substantial. At the present time, as we glean from a pamphlet issued by M. Solvay, containing a history of the new industry and a statement of its commercial status, the annual production of soda by the ammonia process has reached 88,000,000 pounds, or about 44,000 tons, a handsome advance of one thousand per cent. over the 4,000 tons which represented the total production of soda by ammonia, at Vienna, in 1873, a period of only five years.

The noteworthy characteristic of the soda made by this process is its extraordinary purity, a circumstance which, in operations of such magnitude, is quite exceptional, and which must exercise the most favorable influence upon the future extension of the manufacture. The results of several official analyses which are given below will suffice to illustrate this fact, to wit:

	(1)	(2)	
Carbonate of soda (soda)	99·632	99·438	per cent.
Carbonate of magnesia	0·021	trace	"
Carbonate of lime	0·071	trace	"
Alumina	0·009	trace	"
Oxide of iron	0·003	0·001	"
Chloride of sodium	0·064	0·21	"
Silicic acid and carbon	0·053	0·04	"
Water	0·147	0·31	"
	100·000	100·000	per cent.
Total percentage of all impurities, excluding water	0·221	0·252	per cent.

The ammonia-soda, it will be observed from the above analysis, is almost chemically pure, and when the extent and variety of the industries are considered in which soda is used, and when the purity of this substance is an important element of success in manufacture, as regards quality of product, it will be manifest that the successful production on the commercial scale of (almost) chemically pure soda, must indirectly exert a most beneficial influence upon many industries, in the substantial improvement of the product of manufactures employing soda. Of this fact, one illustration will answer our purpose. In glass making, the presence of iron and sulphate of soda, both of which impurities exist in Leblanc soda, is very objectionable, in deteriorating the purity of the glass. From these injurious impurities the Solvay soda is almost absolutely free, on which account it is of special value for glass making purposes, and is steadily growing in favor with glass makers. In the manufacture of certain coloring matters, notably in that of ultramarine, it is said to be now exclusively used, and for every other purpose for which commercial soda is used, the ammonia-soda is said to be steadily growing in favor.

A NEW DETERMINATION OF THE CHEMICAL EQUIVALENT OF ALUMINUM.

TERREIL has recently presented to the Société Chimique de Paris a paper upon the equivalent of aluminum. His method was based upon the decomposition of hydrochloric acid gas by metallic aluminum, and measuring the quantity of hydrogen gas liberated by this operation. While engaged in this work he became satisfied of the existence of a protochloride of aluminum, analogous to the protochlorides of chromium and of iron.

The operation consisted in placing a known weight of aluminum in a hard glass tube in a furnace where it could be heated to redness. At one end was a gas delivery tube dipping into water, at the other end a current of dry hydrochloric acid was admitted. The air was expelled by a current of carbonic acid, which is complete when the gas is entirely absorbed by caustic potash. The tube being heated to redness, and pure hydrochloric acid passed through, the gases are collected in a graduated tube. When no more hydrogen is set free, carbonic acid is again passed through the tube. The latter is then removed by agitating with caustic alkali.

Using 0·41 grm. of aluminum, he obtained 508·2 c.c. of hydrogen (reduced to 0° and 760 mm.), which weighs 0·0455 grm., from which we have:

$$0{\cdot}0455 : 0{\cdot}4100 :: 1 : x, \text{ or } x = 9{\cdot}01.$$

This quantity of hydrogen was formed by the decomposition of 1·6584 grm. hydrochloric acid, containing 1·6129 of chlorine, which must have been absorbed by this 0·410 grm. of aluminum. The chloride of aluminum formed must have the following composition: Aluminum, 20·26 per cent.; chlorine, 79·74 per cent. If we take the equivalent of aluminum at 9, this chloride has the formula $AlCl$; but taking it at 13·5, it has the formula Al_2Cl_3. The latter corresponds with the specific heat of aluminum, its isomorphism and the vapor density of its chloride.

The chloride of aluminum obtained by Terreil is pulverulent and snow white, but becomes yellow when exposed to the air. It has a great affinity for water, and in contact with it a sort of explosion ensues, producing intensely white vapors. Its solution does not reduce the salts of gold as the protochlorides of chromium and of iron, and toward reagents it acts like a solution of the ordinary chloride of aluminum.

COMPRESSED GAS.

THE gas manufactured by the system invented by Julius Pintsch, of Berlin, seems to possess many advantages for lighting railway carriages, steamers, isolated houses, floating buoys, and the like. The gas is distilled from fat or petroleum refuse, has about six times the illuminating power of ordinary coal gas, and is said to cost no more per 1,000 feet even in Europe, where petroleum is much more expensive than here. The use of Pintsch gas in a compressed form is

very extensive in Europe, and is especially adapted for lighting railroad cars, steamers, ferries, mines, streets, parks, and in buoys to mark the entrance of harbors and places difficult to navigate at night. It has been used with success for several years in Germany, Russia, and England, and there are now about 6,000 cars of the principal European railways provided with Pintsch gas, the inventor having received different gold medals, the latest from the Society of Arts in London, in a railway lamp competition. In consequence, the Metropolitan Underground Railroad of London has adopted it for the whole line.

The compressed gas is used in the following way: From the meter it passes into a small gasometer, which, in proportion to the production, requires only a capacity of from 1,200 to 1,800 cubic feet, as during the process of making the gas is compressed into holders, and so kept in stock for use in carriages, ships, lampposts, etc. An iron cylinder, about 6 feet long and 18 inches diameter, is large enough to contain compressed gas for 72 hours for one burner, under a pressure of 90 lbs. The gas passes from the cylinder to the burner through the regulator, which is the most important feature of the system. The construction of the regulator is peculiar. It consists of a cast iron conical vessel of about 12 inches diameter and 6 inches high, the upper part of which is closed by a gastight membrane. To the center of this is fastened a rod with movable joint, and this again is connected with a lever attached to a valve, and by means of this and springs, a perfectly even pressure at the burner is maintained under all circumstances.

At his works near Berlin, Mr. Pintsch is said to give employment to more than 1,000 persons in manufacturing apparatus. There is talk of the adoption of the gas for lighting the cars of the elevated roads in this city.

ABSORPTION OF GASES BY CHARCOAL.

ON A NEW SERIES OF EQUIVALENTS OR MOLECULES.*

By R. Angus Smith, Ph.D., F.R.S.

In the Transactions of the British Association, 1878, Norwich, on page 64 of the Abstracts, there is a preliminary notice of an investigation into the amount of certain gases absorbed by charcoal. I made the inquiry from a belief previously expressed in a paper of which an abstract is in the Proceedings of the Royal Society, page 425, for 1863. I said in that paper that the action of the gas and charcoal was on the border line between physics and chemistry, and that chemical phenomena were an extension of the physical; also that the gases were absorbed by charcoal in whole volumes, the exceptions in the numbers being supposed to be mistakes. The results given were:

Hydrogen	1·00
Oxygen	7·99
Carbonic oxide	6·03
Carbonic acid	22·05
Marsh gas	10·01
Nitrous oxide	12·90
Sulphurous acid	36·95
Nitrogen	4·27

It was remarked that the number for nitrogen was probably too low; I had some belief that the charcoal retained a certain amount which I had not been able to estimate.

For common air, the number 40·065 crept into the paper or abstract instead of the quotient 7·36.

I considered the numbers very remarkable, but was afraid that they would be of little interest unless they could be brought more easily under the eyes of others; my experiments were somewhat laborious; the exact numbers were seldom approached by the single analysis, but were wholly the result of a series of irregular averages and apparently irregular experiments. The cause of this was clear, as I believed, namely, the irregular character of the charcoal with which I had to deal. The experiments were forgotten, I suppose, by most men, but the late Prof. Graham told me that he had repeated them with the same results that I had published. I might have considered this sufficient, but waited for time to make a still more elaborate investigation of the subject, and to take special care with oxygen, in the belief that, the rule being found, the rest of the inquiry would be easy; this was extended to nitrogen, but not by so many experiments as with oxygen. I am now assured of a sound foundation for inquiries, which must take their beginning from the results here given.

It is found that charcoal absorbs gases in definite volumes, the physical action resembling the chemical.

Calling the volume of hydrogen absorbed 1, the volume of oxygen absorbed is 8. That is, while hydrogen unites with eight times its weight of oxygen to constitute water, charcoal absorbs eight times more oxygen by volume than it absorbs hydrogen. No relation by volume has been hitherto found the same as the relation by weight.

The specific gravity of oxygen being 16 times greater than hydrogen, charcoal absorbs 8 times 16, or 128 times more oxygen by weight than it does hydrogen. This is equal to the specific gravity of oxygen squared and divided by two, $\frac{16^2}{2}$, or it is the atomic weight and specific gravity multiplied into each other, 16×16, and divided by two, $\frac{256}{2} = 128$.

Nitrogen was expected to act in a similar way, but it refused. The average numbe of the latest inquiry is 4·52, but the difficulty of removing all the nitrogen from charcoal is great, and I suppose the correct number to be 4·66. Taking this one as the weight absorbed, 14×4·66 = 65·3, or it is $\frac{14^2}{3}$.

Oxygen is a dyad; nitrogen a triad.

We have then carbonic acid not divided, but simply 22 squared = 484.

Time is required for full speculation, but the chemist must be surprised at the following:

Carbonic oxide	6		volumes.	
Carbonic acid, CO_2	6 + 16		"	= 22·00
Marsh gas, CH_4	6 + 4		"	= 10·00
Protoxide of nitrogen, NO	8 + 4·66	(N)	(4·9)	= 12·66

These four results belong to the early group, not corroborated lately, but so remarkably carrying out the principle of volume in this union, giving numbers the same as those of weight in chemical union, that they scarcely require to be delayed.

I am not willing to theorize much on the results; it is here sufficient to make a good beginning. We appear to have the formation of a new series of molecules, made by squaring our present chemical atoms, and by certain other divisions peculiar to the gases themselves. Or it may be that the larger molecule exists in the free gas, and chemical combination breaks it up. These new and larger molecules may lead us to the understanding of chemical combinations in organic chemistry and whenever there is union not very firm, and may also modify some of our opinions on atomic weights and the motion of gases.

Of course, I cannot pretend to give the result of these results; but as we have here the building up of a molecule by volumes, so as to form an equivalent of physical combination analogous to the chemical equivalent, it is impossible to avoid seeing that it indicates the possibility of our present equivalents being made up in a similar manner.

I did not expect these numbers, but I certainly, as my previous paper showed, had in full view a necessity for some connection between physical and chemical phenomena more decided than we possessed.—*Chemical News.*

* Abstract of a paper read before the Royal Society, Feb. 6, 1878.

IMPORTANT EXTENSION OF THE USE OF THE BLOWPIPE IN QUANTITATIVE DETERMINATIONS.

At a late meeting of the Academy of Medical Sciences of Philadelphia, Professor George Aug. König, of the University of Pennsylvania, exhibited his recently invented "chromometer," explaining its application and construction. By means of this instrument the beautiful and well-known colors, which certain metals impart to the glass fluxes, notably to sodium biborate, and to sodium metaphosphate (microcosmic salt), are made use of in the quantitative estimation of these metals. The problem involved in this method required, first, the preparation of a glass-bead containing the flux and assay substance in known proportion. In this there is no difficulty. Five or ten milligrammes (if possible the latter) are placed on a platinum foil, forming the pan of delicate assay balance (sensitive to 1-20 milligramme), then 95 or 90 of the anhydrous flux are weighed, and the two fused together in the loop of a platinum wire (weighing exactly 1 decigramme). After complete solution in a clear oxidizing flame, the wire and bead are replaced on the balance, to make up a possible deficiency in case the substance contains water or other volatile compound. Then the bead is again melted, and while liquid, thrown into a porcelain evaporating dish. Any flux adhering to the wire will be immaterial, since the ratio remains the same. By fusing it now into a platinum cylinder (inner diameter=0·145 of an inch, height =0·09 of an inch), the bead will become easily manageable in all further operations. The dimensions of the ring have been chosen as above, because 100 mgrs. of glass will project sufficiently on either side to allow the cutting of two plane parallel faces with emery and water on a glass plate and a simple holder. These two faces are at a constant distance of 0·12 of an inch. A gauge, consisting of slot of that width in a brass plate, into which the bead must slide with easy friction, serves to attain this purpose. The operation of cutting, after short practice, may be performed in three minutes, or even less. In order to restore transparency of the bead, and also to preserve it for an indefinite length of time from the moisture in the air, the bead is warmed, and a very thin film of Canada balsam is applied to the cut faces with a fine brush and an alcoholic solution of the balsam. The bead is now ready to be placed into the chromometer. This instrument is based upon the physical law, that complementary colors destroy each other. If, for instance, two solutions, the one green, the other red, are mixed together in certain or equivalent proportion, a colorless liquid will be produced, supposing that no chemical reaction takes place between the two coloring substances. Similar colorlessness will result if to a green glass an equivalent portion of red glass be added by fusion. It is known that the orange yellow color imparted to a non-luminous flame by a sodium salt, is completely obliterated, when looked at through a glass colored blue with cobalt, or a glass vessel containing a solution of indigo. A hollow glass prism, containing such solution, is found very serviceable in detecting the purple and red colors given to the flame by potassium and lithium salts, when mixed with sodium salts. Well-known as these qualitative reactions are, no attempt has as yet been made to employ them in quantitative determinations. The chromometer is proposed to serve for this purpose. In its simplest form it is composed of a prism cut from red glass, or green glass, three inches long, with a taper not exceeding three degrees of an arc. The slide upon which the prism is mounted is movable by rack and pinion, carrying a fixed scale, graduated to 1-10 of an inch. In a tube of proper diameter at right angle to the prism, the prepared glass bead is inserted and looked at through an adjustable lens, the light coming from an unglazed white paper screen, mounted opposite in the prolonged axis of the bead. Let the bead contain 5 mgrs. of a manganiferous iron ore; the color of the bead will be brown or blood-red, according to the quantity of manganese present. The green prism is placed on the slide, so that its thinnest part is at the zero-point of the scale. Moving it forward, now, we notice how the blood-red passes gradually into brown, then into yellow, and presently a green shade mixes with the yellow, growing stronger, until it passes into the emerald green of the prism toward the latter's thickest part. The transition from brown through yellow into green is very sharp and sudden, and indicates the point at which the red color of manganese is just extinguished, leaving the yellow of the iron pure. This is the point of extinction, and the scale-reading is noted. Had there been no iron, but only manganese, or this with some non-coloring substance, the point of extinction would have been perfect colorlessness. Thus it is seen that the color of the metal sought is picked out from all others; the color is measured, hence the word chromometer. If two beads have been made, containing known quantities of manganese, the one, for instance, 0·070 mgr., the other, 0·205 mgr., and the points of extinction were found at 10 and 35 on the scale, then the co-efficient of extinction for manganese and for the given prism will be 0·135+20=0·0067 mgr. Mn. Supposing the reading of the bead containing the iron ore had been 13, the result would be

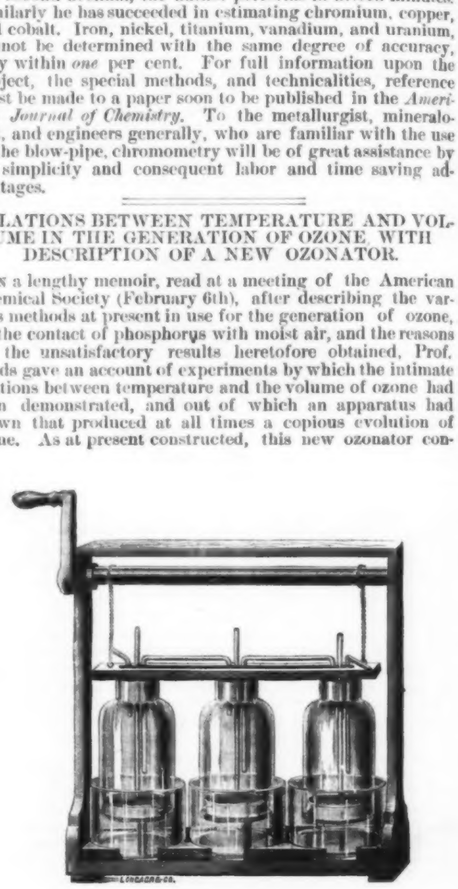
0·070+(3×0·0067 =0·0901

5 : 0·0901=100 : 1·802 (the percentage of manganese).

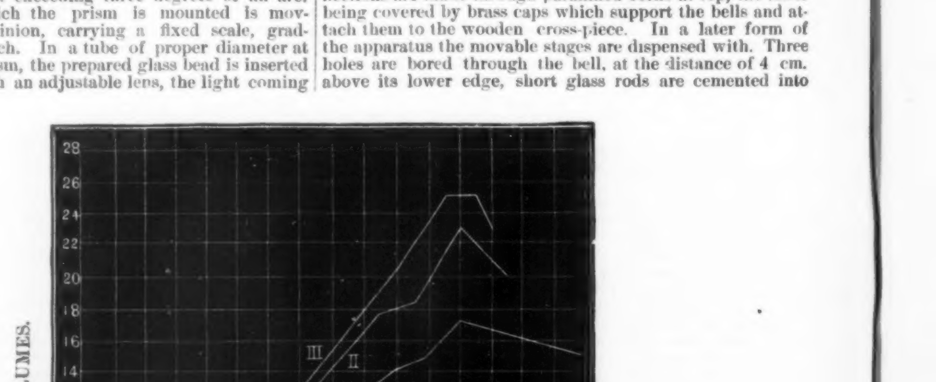
Such a determination of manganese, which is accurate to the second decimal, the author performs in fifteen minutes. Similarly he has succeeded in estimating chromium, copper, and cobalt. Iron, nickel, titanium, vanadium, and uranium, cannot be determined with the same degree of accuracy, only within *one* per cent. For full information upon the subject, the special methods, and technicalities, reference must be made to a paper soon to be published in the *American Journal of Chemistry.* To the metallurgist, mineralogist, and engineers generally, who are familiar with the use of the blow-pipe, chromometry will be of great assistance by its simplicity and consequent labor and time saving advantages.

RELATIONS BETWEEN TEMPERATURE AND VOLUME IN THE GENERATION OF OZONE, WITH DESCRIPTION OF A NEW OZONATOR.

In a lengthy memoir, read at a meeting of the American Chemical Society (February 6th), after describing the various methods at present in use for the generation of ozone, by the contact of phosphorus with moist air, and the reasons for the unsatisfactory results heretofore obtained, Prof. Leeds gave an account of experiments by which the intimate relations between temperature and the volume of ozone had been demonstrated, and out of which an apparatus had grown that produced at all times a copious evolution of ozone. As at present constructed, this new ozonator con-



sists of a series of three bells, which can be readily raised or lowered by means of a windlass and chain. These bells are provided with an exit and entrance tube, and in the earlier form of the apparatus, with a glass rod sliding up and down, and carrying a glass or leaden stage. The connections are made through paraffined corks at top, the latter being covered by brass caps which support the bells and attach them to the wooden cross-piece. In a later form of the apparatus the movable stages are dispensed with. Three holes are bored through the bell, at the distance of 4 cm. above its lower edge, short glass rods are cemented into them, upon which glass or lead disks are placed. These disks have slots corresponding to the rods, upon which they may be made to rest by rotation through a small arc. The bells are lowered into glass jars, which contain a solution of 25 grms. potassium dichromate and 150 c.c. sulphuric acid in 1,250 c.c. water. This mixture keeps the surface of the phosphorus always clean, and is constantly drawn in ripples over the phosphorus by energetic surface action. A



TEMPERATURES.

stronger dichromate solution gives somewhat higher rates, but is objectionable on account of the too rapid oxidation of the phosphorus. These jars are set in a shallow copper water-bath (not shown in the figure), by means of which their temperature can always be maintained at or near 24° C., the temperature that Prof. Leeds has shown to be the temperature of maximum evolution of ozone.

It is essential that the phosphorus should be cast into segments of spheres, which can be quickly done by melting it in watch-glasses of equal size heated under water. If employed in the form of sticks, their irregular wasting away not only rapidly diminishes the ozonizing surface, but greatly increases the danger of inflammation. Each segment exposes 9 sq. cm. of area above the surface of liquid, or 150 sq. cm. in the three bells.

The ozonator is connected with a wash-bottle by means of flexible tubing. Since India-rubber is instantly destroyed, great difficulty was encountered in procuring a substitute. After many experiments a variety of "kerite" was manufactured by Mr. A. G. Day, the patentee, which has not been visibly affected after many weeks of service.

It will be seen from the diagram that the amount of ozone generated when one bell is employed and water in the jar (curve O) is much less than when the dichromate mixture is employed under like circumstances (curve I.). In the former case, at 25° each liter of air drawn through the apparatus contains 1·05 mgrm. ozone, or 0·494 c.c.; in the latter, at 24°, each liter contains 1·86 mgrm., or 0·87 c.c. The volume-ratio is as 9·9 to 17·4 (see figures at left of diagram). When two bells with dichromate were employed, the ozone generated at 24° amounted to 2·46 mgrms. per liter (curve II.), and generally at any temperature it was 25 per cent. greater than for the same temperature with one bell-jar. With three bells the amount formed at 24° was 2·68 mgrms., or 1·26 c.c. ozóne per liter. No ozone is given off at 6°, and after passing the maximum the curve again falls off rapidly. It is curious to note that the elements of curve I. satisfy the equation of an oblique hyperbola of the primary order.

COLD WATER IN TYPHOID.*

By J. W. KIBBEE, M.D., New York.

IN the spring of 1878 I took my family from this city to Highlands, Macon County, North Carolina, in order that they might reap the benefits offered by its climate, which, I am fully persuaded, is the best in North America for chest diseases—functional or organic—and for nervous affections. These Highlands are near the southwestern terminus of the Blue Ridge Mountains, and rise abruptly to what is called a plateau—really an undulating level—whose average height above the ocean is about 4,000 feet, with numerous peaks shooting up a thousand feet or so. The atmosphere of this elevated region is almost "moteless" (Tyndall), not one of the zymotic diseases having ever been known to originate in it, due doubtless to the fact that the air is of the upper strata, unmixed with that which floats over the surrounding low country. Just below this plateau, however, at an altitude of some two thousand feet or less, fevers of every type common to our country prevail. I had not sojourned long at Highlands before receiving calls for the treatment of typhoid fever. The case I am about to present is peculiarly interesting on account of its apparently mild beginning, and its resulting in congestion and hemorrhage before the patient or his friends were aware that there was fever at all. On the 4th of July we had a little celebration at Highlands, and the patient, Evan Nicholson, a schoolteacher, aged twenty-five, rode from his home in Oconee County, South Carolina, fifteen miles, on horseback, with his friends. In conversation with me that day he stated that he had felt unusually bad for several weeks, that there had been for some time a tenderness in the hypogastric region, and occasional vertigo, with a dull headache that was almost constant. He did not ask for a prescription, but said he would consult me soon in regard to a chronic nasal catarrh. I afterward learned that on his return home the jolting of horseback riding occasioned great pain in his bowels and head. . . . At daylight on the morning of the 25th of July I was called in haste to visit him. The messenger, his brother, stated that he had kept up about the house all the time since the 4th, until the morning before, having taken large quantities of patent pills, salts, oil, etc., to keep his bowels open, that he had had a slow, weak pulse, and, although the weather was very hot, was inclined to keep his coat on during the heat of the day. At about 12 M. the day before there commenced a great excitement in the circulatory and respiratory systems, the pulse running up to 140 per minute and the respirations to 30. This account of the circulation and respiration is a matter of judgment formed from the accounts of the patient and his friends; the heat, it was also said, was intense. At 7 P.M. of that day, the 24th, there was a dejection of about two quarts of blood, very putrid and offensive to the sense of smell. Several dejections followed, resulting in a loss, at midnight, of a large quantity of blood, when syncope occurred. I found him, eight hours afterward, with very cold extremities and just a thread of pulse at the wrist. Notwithstanding the coldness of the limbs, the hypogastrium was quite hot, so a thickly-folded cloth was wet in cold water and laid over it, and the legs and feet, arms and hands, were wrapped in heated flannels, both being renewed at short intervals. An infusion of the leaves of the *hamamelis virginica*, well sweetened with loaf-sugar, was given, two tablespoonfuls every half-hour. No more dejections followed; the patient remained in the supine position until four o'clock on the morning of the 26th, when reaction, which had been slowly returning, was fully established. The pulse was then 130 per minute, strong but wiry, and the heat, having been to a great extent controlled by the cold wet compresses over the bowels, was general, and rapidly evolved by the exalted vital action. Having, unfortunately, broken my thermometer, I had no means of determining the exact temperature, and was compelled to fall back upon a plan I had adopted many years ago while treating fever by the cooling process. After considerable experimenting, I found that in fever of any name the thermometer would show a heat of 98½° to 99° Fahr., when the skin of the whole trunk was kept, by either pouring or packing, so that it felt cool to the hand of the healthy attendant.

At four o'clock, then, on the morning of the 26th, twenty hours from the beginning of the treatment, and twenty-eight from the period of syncope, when the hemorrhage ceased, thorough treatment of the fever was begun by placing the patient on a well-filled straw bed, folding a sheet so that it would reach entirely round the body from the hips to the arm-pits, and wetting in spring water at about 60° Fahr. The patient, still supine, was gently raised to a recumbent position, the wet sheet laid on the bed under him, when he was placed upon it and it was folded entirely around the trunk. For the eight following days the wet sheets were cooled and freshly applied every twenty minutes to half an hour, according to the exacerbations of heat, as determined by the hands of the attendants, placed upon the skin of the trunk. The extremities all this time were kept warm by the use of flannels, and woolen blankets when needful. About thirty hours after the syncope an enema was administered, composed of an infusion of hamamelis leaves and mucilage of slippery elm. The patient was quiet while fully two quarts were gently injected, which thoroughly cleansed the lower bowels from the clotted, putrid blood that remained in them after the syncope and reaction.

Twenty-four hours afterward a mild cathartic was administered, composed as follows: R. āā senna, ʒss.; jalap, ℈j.; caryoph., gr. ij.; aqua ferv., ℥iv. Sweeten with coffee or loaf-sugar, and drink warm. This brought away in a few hours the putrid blood that remained above the reach of the enema, and with it considerable fecal matter. No other medicine was given save a weak infusion of the hamamelis, and, for the first three or four days, an occasional spoonful of the slippery elm. The pulse, after the first application of the cold wet sheet, was about 120 for eight days, after which time it fluctuated between 90 and 100 for two weeks, when it became full and soft at 75, the patient being then clear of morbific matter. The appetite was good, even keen, after cooling the heated blood on the morning of the 26th; and gruel, fresh milk, and fruit—apples, peaches, and blackberries—were taken freely, fully enough to support a well man if lying still. After the first movement from the medicine, the bowels acted every morning, under the stimulus of a warm-water enema, the fecal matter being of the proper consistence, color, and quantity. The urine was abundant, rather highly colored, and strongly scented. The sleep was quiet and refreshing, and there was no nervousness or delirium, the tongue was clean, and the breath not particularly offensive. For the first two weeks the patient was wholly unable to turn himself in bed, but gradually gained strength, so that three weeks from the hemorrhagic crisis he was able to sit up in a rocking-chair for an hour at a time, bear his weight on his feet, and walk across the floor with assistance. There are several points of interest attaching to this case, which we will now consider. In the first place, we notice that the young man's vitality was so depressed or oppressed by inimical matters or conditions, that it had not sufficient force to manifest the two essential phenomena of fever—the exalted action of the heart and lungs, and the consequent excess of heat—hence the slow, weak pulse, and the constant chilliness of the surface until the reaction after the hemorrhage and syncope. We see that the cause of the congestion was the oppressed vitality, or the inability of the heart to drive the blood along through the intestinal capillaries, where it lodged, became devitalized from want of oxygenation, and was at last driven through the relaxed depurating surface into the prima via by the aroused and almost expiring efforts of the vital force, producing hemorrhage of the bowels, a very grave symptom, not so much on account of the loss of blood as by showing the little vitality in that remaining, and the amount and power of the cause of vital disturbance. We notice in this case that there was vitality sufficient to cause reaction from the syncope, or contractile power enough to close the relaxed walls of the capillaries after the devitalized blood had passed through. We see that after the expulsion of the devitalized blood there was power to cause the heart to beat with considerable force at 130 per minute, the lungs being excited to a correspondingly increased action, causing a rapid evolution of vital heat.

Let us consider for a moment the results of the cooling treatment in this case. In cases of local injuries, and severe operations with the knife, as Dr. Thomas has shown, the exalted action of the heart and lungs consequent upon the local lesion is greatly reduced upon removing the excess of heat; but, where the cause of the vital disturbance affects the whole system—as the zymotic causes, for instance—the reduction of the cardiac and pulmonary action by the cooling process is but slight. In typhoid, in pneumonia, in scarlet fever, in yellow fever, and in other high grades of vital action, I have rarely seen the cardiac action lessen more than ten beats per minute upon the reduction of heat from 4° to 6° by the cooling process. In this case the pulse fell from 130 to 120 upon cooling the blood, and remained there for about eight days, when it gradually fell off to the normal beat, the evolution of heat decreasing in exact ratio. We are shown by this that, while the circulatory and respiratory action is nearly double the normal, if the excess of heat be removed as fast as it is evolved, every depurative function is performed as perfectly as in health; and, what is of equal consequence, digestion and assimilation are but slightly disturbed. During the eight days of cardiac and pulmonary excitement, this young man ate heartily and with excellent relish, and the proof that digestion and assimilation were perfect was the fact that the fæces were natural in color, consistence, and quantity. Were this case as given here, were all the very numerous and varied cases of fever that I have treated on the cooling principle for many years brought only into the count as proof of the great benefits of equalizing the temperature with water in all vital disturbances, there might be room for question, for doubt, in this matter; but the medical world is finding similar proofs of the value of water as an antipyretic from all quarters of the globe; and the conviction is becoming settled, in the minds of the thoughtful in our profession, that we are on the eve of a great revolution in the treatment of fever—a revolution which will practically sweep away all the distinctions heretofore made on account of the inherent differences in the vital or non-vital causes of our vital disturbances—variola, rubeola, scarlet fever, yellow fever, etc., for instance—and place the practice of medicine on a sure foundation, a practical basis, one that cannot be mistaken in its primary and great central requirement, the normalization of the temperature with water. When this is done, as is easily seen, none of the morbid symptoms attending fever of every name will occur at all, since they can all be traced directly to the influence of excessive heat, and in no instance to the exalted vital action.

This young man was treated by the frequent packing of the trunk with the folded sheet, made dripping wet, the straw bed being changed every day; but it occasioned a great amount of care from several assistants, since he was wholly unable to help himself in the least for a long time. This extra labor would all have been obviated had the fever-cot been available. Some two weeks after the hemorrhagic crisis of Evan, his brother, James Nicholson, aged 30, came down with the same disease, but in a much more violent form, he being possessed of a larger share of vitality, which, of course, showed a greater resistance to the offending causes. This time a fever-cot was procured, and the excess of heat was controlled with comparatively little trouble, the patient going through the whole period of exalted vital action with a good appetite, the digestive, assimilative, and depurative functions being well performed. Can we do less than form the conclusion that all the morbid phenomena attending fever of any name are directly due to excessive heat, and that its removal with water is a sure remedy?

* *N. Y. Medical Journal.*

BRONCHIAL ASTHMA.

From a lecture delivered at the Medical Society of London in February, 1879, by JOHN C. THOROWGOOD, M.D., F.R.C.P., Physician to Victoria Park Hospital for Diseases of the Chest, Physician to the West London Hospital, and Lecturer on Materia Medica at Middlesex Hospital.

EXPERIMENT and observation have proved how much the action of the lungs is under the influence of the pneumogastric nerve, and reflection on the course and connections of this widely distributed nerve will help to explain why it is that our treatment of asthma must be varying in its nature, and cannot always be as certain in result as we could wish.

To cure asthma we often have to direct our remedies to organs other than those of respiration. The way to success may lie in the correct adjustment of a displaced womb, in the administration of a dose of extract of male fern to destroy a tapeworm, or in a course of Carlsbad waters to eradicate gout from the system.

The capriciousness of bronchial asthma with regard to external influences is well exemplified by the effect of climate on the complaint. To many asthmatics the pure clear air of such places as Margate, Whitby, or Nice is absolutely unbearable, and we find patients hurrying away from such climates, almost in terror of their lives if another night be passed therein. Dr. Salter has gone into the history of twenty-one cases of asthma powerfully influenced by atmospheric surroundings, and the outcome of evidence is conflicting and unpractical. Fourteen could respire with comfort only in the smoky air of populous cities; eleven, indeed, seemed cured by the air of London. Seven others were unable to live in close towns, and did best in the country.

One patient of my own, a great sufferer from asthma at his house in the country, passed six weeks in Queen Anne street, Cavendish square, without experiencing a single attack of breath spasm. On returning home he was at once taken in the night with so alarming a seizure that he had to send urgently for his regular medical adviser. Another patient was glad to quit his well furnished abode in the northern outskirts of London and take up his residence at his business premises in Cornhill, for there he could rest at night without fear of an attack of asthma. Those who have read Walshe's work on the lungs will remember the instance of the man, sorely tormented with incurable asthma near Hampstead, who was absolutely cured by changing his residence to the more central region of Seven Dials.

I once thought it might be the absence of ozone in the air of cities that renders it sedative to irritable air tubes, but though experiment and observation clearly show that ozone produces catarrh, and even pulmonary inflammation, yet bad asthmatics have been known to make a voyage to Australia without experiencing any approach to a seizure the whole time, though the air was shown to be often highly charged with ozone.

Among remedial agents employed during a bad paroxysm of asthma, few are more universally known and employed than the smoke of burning niter paper. Ordinary blotting paper is soaked in a strong solution of nitrate of potash, and, when dry, is burnt till the patient's room is filled with a cloud of nitrous fume, and often it is not till the room is thus filled with smoke that the sufferer finds relief. As long ago as 1846 we find this use of niter paper highly extolled in the *Medical Gazette;* and in the *Lancet* of April 5th, 1845, we learn how a friend of Mr. Harrison's tried burning paper that had been soaked in saturated solution of nitrate of potash, and felt the inhaled smoke to clear the passages and open the air tubes, and so conduce to free and easy respiration. Though some amount of emphysema and bronchitis does not invalidate the action of the nitrous fume, yet it is in the spasmodic sudden attacks of breath stoppage where its curative action is most marked. The chemical constituents of the fume have been examined by M. Vohl, and he found the nitrous vapor to contain cyanogen, carbonic acid, nitrogen, ammonia, and nitrite of potash. To the ammonia and nitrite of potash the anti-spasmodic property of the fume is attributed.

Noticing that the constituents of the nitrous vapor are closely allied to some of the adventitious matters found in the close air of towns, I went over Salter's table of 223 asthmatics to see if I could discover that those persons who are set down in the table as being notably relieved by the inhalation of the nitrous vapor were identical with those to whom town air proved so beneficial. I found that, of twenty-one who are said to have been greatly benefited by the air of London, there were nine to whom the niter paper was of marked service. Two, who are reported as cured by the London air, found niter paper inhalations more serviceable than anything else. One patient, whose sufferings were intensified in London, reports that niter paper seemed to do harm rather than good.

Probably it is to the ammonia and carbonic acid gas that we may attribute the anti-spasmodic action of the burning paper.

It has been shown by Trousseau how useful the inhalation of diluted ammonia can be in asthma; and Salter records a case where asthmatic spasm was at once stopped by breathing the vapor of diluted ammonia. The fact that the emanation from certain gas products is reputed good against the convulsion of whooping cough, and that an asthmatical sea captain could always breathe with facility when conveying a cargo of guano, are additional proofs of the anti-spasmodic action of ammoniacal vapor.

Among internal medicines that are good against spasmodic asthma, even when some degree of chronic bronchitis coexists, a high place should be given to the arseniate of soda. In a commencing dose of one-twentieth of a grain, either in pill or solution, this salt has a great power of promoting respiratory action, and appears, moreover, to act as a tonic to the system, for I have noticed patients to gain appetite and weight during its administration. The Bourboule water,* so beneficial as a drink for those subject to asthma, apparently owes its efficacy to a trace of arseniate of soda in its composition.

Arsenic smoking, by means of cigarettes containing from

* See Notes on Asthma, fourth edition, p. 97.

a quarter to half a grain of arseniate, is very comforting to those who suffer from hay asthma, or from ordinary spasmodic asthma, provided no feverishness of system or inflammatory action be going on. Dr. Wilks told me some time ago of a former patient of his at Guy's Hospital, who, in his trade as a bird stuffer, used much white arsenic. This man was asthmatical and a smoker, and, when taken with one of his breath attacks, he usually added some of his white arsenic to the contents of his pipe, and speedily found relief.

Lately the iodide of ethyl has been employed as an inhalation in the treatment of asthma. Pure iodide of ethyl is colorless, but after a while it is apt to acquire a brown tinge, if exposed to the light, from the liberation of free iodine. Dr. Andrew and I have used this preparation in a few cases in the Victoria Park Hospital, and with beneficial result. In one case under my care a young woman had an asthmatic seizure every morning at 4 A.M. of some severity, but was eased much by the use of strong coffee. We gave her for a week ten drops of the iodide of ethyl on lint three times a day for inhalation, and at the end of the week she had lost her cough as well as her asthmatic attacks, nor did they show any sign of returning during the remaining three weeks of her stay in the hospital. My clinical assistant, Mr. McDonald, was able to detect iodine by the starch test in the urine and expectoration of those who were inhaling the iodide of ethyl.

In two cases recently I have observed excellent effects follow on the employment of the citrate of caffeine. One patient was an eminent medical practitioner in a large town in the north. He had suffered most severely from paroxysmal asthma, and the utter failure of a list of approved inhalations and medicines (far too long to be here enumerated) was most distressing. Four grains of citrate of caffeine produced an undue degree of wakefulness, but one grain, taken regularly at bedtime, had a most happy effect indeed. So far as we can at present judge, it appears to have been really curative of the asthma. The last report says: "*Pari passu* with the asthma my cough and expectoration have gone, and I now have next to none of either."

In another case, a highly informed and observant patient of Dr. Kingsford's, who had found much benefit from the inhalation of iodide of ethyl for an asthma and bronchitis of twenty years' standing, tried the citrate of caffeine in two-grain doses every afternoon for a fortnight without any marked result. One day, however, being sadly worn out by a protracted attack of bronchial spasm which had lasted for eight hours, this patient took four grains of citrate of caffeine in coffee, with the effect of obtaining immediate relief to the spasm, followed by three hours' quiet sleep in his chair. The citrate of caffeine appears to allay the abnormal excitability of the nerve centers, and then repose ensues as a natural result.

I have seen similar calming effect from the use of nux vomica in bad emphysematous asthma, with failing pulmonary innervation, and this soothing and soporific action of remedies reputed nerve tonics and stimulants in cases of great exhaustion of the nerve centers is an interesting therapeutical fact, ably set forth by Dr. Milner Fothergill in his Fothergillian prize essay.

The citrate of caffeine is not a new remedy. It has been employed in neuralgic headache and sickness for many years, and a friend of mine saw it given for asthma in Paris more than twenty years ago. Lately Dr. Lewis Shapter* has employed the citrate as a diuretic in cardiac dropsy. Like belladonna and atropia, caffeine appears to stimulate the respiratory and circulatory nerve centers, and to increase the blood pressure in the small vessels, so that it may prove an efficient diuretic. As such it may be employed in cardiac dropsy, where digitalis does not appear to agree. The citrate of caffeine, a fine specimen of which has been sent to the society by Messrs. Corbyn, occurs in delicate silky crystals soluble in water, but best administered in a small cup of coffee. The dose may commence with one grain and extend to four or five.

Space does not allow me to dwell further on the subject of the treatment of asthma. In old standing emphysematous asthma it is important to relieve any abdominal plethora and congestion of liver, and when this is done by means of saline aperients, Carlsbad salts, and abstinence from all forms of alcohol, then great benefit will often follow on the use of small doses of the extract and tincture of nux vomica. I have repeatedly proved the value of nux vomica and strychnia in cases of emphysematous asthma, with very prolonged expiration, and apparent tendency to paralysis of bronchial muscle. It is in cases of old emphysematous asthma that the compressed air bath is so much commended.

My experience of this mode of treatment is not very great. I have known a well arranged compressed air bath perseveringly tried by a youthful subject of bronchial spasm, whose heart and lungs as yet manifested no sign of structural change, without any beneficial result. In the case of elderly persons with overfilled lungs, long weak expiration, and tendency to obstruction of the circulation, I certainly think the bath is worth a trial. In one case of this description a free expectoration came on under the influence of the compressed air, and in another the effect of the bath was to cause tranquil and refreshing sleep. One great effect of the compressed air bath I consider is the production of more perfect oxygenation of the blood, hence its very marked effect in curing cases of obstinate anæmia. Coupled with this we may bear in mind the fact that the inhalation of oxygen gas has been found by Dr. Cayley and others of great service in relieving the dyspnœa of chronic emphysematous bronchitis, and also that Trousseau,† in treating some very severe forms of anæmia, found no remedy so powerful as the inhalation of oxygen.—*Lancet.*

LEPROSY IN AMERICA.

THE following facts regarding the present state of that terrible and incurable disease, leprosy, as it exists in certain foci, within and immediately beyond the borders of the United States, are derived from the report of the Committee on Statistics of the American Dermatological Association. The centers of prevalence are stated to be: the Norwegian colony in Minnesota, the blacks and Jews in South Carolina and other Gulf States, and the French residents of Northeastern New Brunswick. The occurrence of sporadic cases in several of the Northern States has been mentioned as established on reliable authority also. These circumstances, together with the fact of the probable penetration of a race greatly prone to disease in large numbers among our people in all parts of the country, in view of the possibility of the disease being transmitted in other ways than by heredity, make the study of the progress of the affection in America one of considerable importance.

The disease appears to have been introduced into New Brunswick in 1815 by a woman of Normandy, named Benoit, and all accounts agree that it has continued mainly in her descendants—the only exception to its confinement to French families being a Scotchman, some of whose descendants have since been affected. The region in which the disease prevails comprises the French settlements, Nequac, Tracadie, and Carraquet, bordering on the Miramichi River, near the Bay of Chaleurs. Active measures were taken to control the disease in 1844 by the establishment of a hospital on Sheldrake Island; this was continued till 1849, when the present lazaretto was built at Tracadie, three or four acres being inclosed by a wall 20 feet high, to prevent the escape of the patients. In 1868 this was placed, and still remains, under charge of the nuns of Hôtel Dieu, of Montreal. The greatest number of patients at any one time was 37. At the present time there are only three known cases of leprosy outside of the lazaretto. There are no police measures to compel residence therein. Lepers are shunned by relatives, and are glad to go to the lazaretto; once in, they never try to escape, although the doors are open day and night. The disease is confined to the most miserable class in Tracadie, most of whom live in great poverty. The affected persons intermarry very freely. The disease is now confined to the immediate vicinity of Tracadie, within a range of seven miles, instead of twenty, as formerly.

Reports of the prevalence of leprosy in the Southern Atlantic States are so limited in number that the disease can hardly be included in the nosography of that region. It is a fact that the affection is never observed by a very large number of the profession in the South, and it is practically a disease to which our own people are not liable. Of the twenty cases reported from the States of Maryland, Georgia, and South Carolina two at least were born in the United States, and one had never been beyond its limits. It is not unlikely that some of the cases observed in South Carolina were also natives of this country, and it is most probable that there have been other cases not reported.

Dr. Gronvold, of Norway, Minnesota, writes that Prof. Boeck, of Christiana, has reported in all eighteen cases of the disease among his countrymen in the West. Dr. Gronvold himself had observed four or five cases among his countrymen, and forwards notes of three more cases never before reported. The cases that have been reported show: (1) an equal representation of the two forms of the disease; (2) its steady progress in those patients who exhibited the first symptoms of the malady in the Old World; (3) a tendency in the *tubercular* to assume the *anæsthetic* phases; (4) no instance in which the disease has been transmitted to children born in America. Dr. Gronvold believes that in his patients the disease would have advanced more rapidly in the Old World.

As regards the Pacific Coast we have no definite information concerning the prevalence of the disease; but from the report of the Health Officer of San Francisco for the year ending June 30, 1875, it appears that the number of cases of leprosy in that city was thirteen, and these were confined to the Chinese Hospital.

From the foregoing facts it would appear that this loathsome disease, as it exists in America, is confined mainly to emigrants from foreign shores and their descendants; and that, although it has been proved contagious, the affliction has been visited thus far on very few native born people.

THE GLOBULAR RICHNESS OF HUMAN BLOOD.

IN an interesting paper on this subject, by Messrs. Cutler and Bradford, contained in the current number of Michael Foster's *Journal of Physiology*, the authors arrive at conclusions that are at considerable variance with generally accepted views. It has hitherto been believed, chiefly on the statements of Professor Hirt, that the number of white corpuscles undergo considerable increase, relatively to the red corpuscles, shortly after food. Messrs. Cutler and Bradford, however, adopting Professor Malassez's method of estimating the number of the corpuscles, found that there was an increase of the red corpuscles after eating, and a decrease of the white corpuscles. They do not pretend to determine the cause of this phenomenon—whether, for example, it is attributable simply to a concentration of the blood during the process of digestion by a demand upon the fluid of the blood made by the secreting glands, which are so active at this period, or whether it is due to a new formation of blood corpuscles, or, lastly, whether an extra supply of the oxygen-carrying elements is thrown into the circulation, as if there were a call upon the reserves during the active processes of digestion. They summarize the results of their observations in the following terms: The globular richness of the blood, or the number of globules in the cubic millimeter of blood, varies greatly in different parts of the circulatory system, and they regard these local variations as being dependent upon the functions of the tissues or organs through which the blood passes, and may be supposed in the main to balance each other. The globular richness of the blood is also affected by general causes, such as the amount of fluid abstracted from the blood (diarrhea, increased urinary secretion, sweating, copious vomiting), and by a deprivation of the regular supply of fluid to the economy. The globular richness appears also to be subject to daily variations; there is a decrease in the globular richness of the red corpuscles during fasting, and an increase after a meal; there is probably an increase in the globular richness of the white corpuscles during a fast, and a decrease after a meal; there is a variation of the globular richness in different seasons of the year; and, lastly, there is a slight variation in the globular richness from one week to another. It is important that these variations should be taken into account by those who attempt to estimate the value of tonic remedies by enumeration of the blood corpuscles.—*Lancet.*

NEW REMEDIES.

From a report read before the District Medical Society of Central Illinois, Oct. 29, 1878, by J. G. HARVEY, M.D.

THE subject of new remedies, and the new application of old, is one full of interest to every intelligent physician, and one which is too much neglected. My conservatism makes me loth to part with an old for a new and untried remedy, and I shall bring to your notice only such articles as have been used and tested by physicians of known veracity and ability. I have long felt the need of some more efficient remedies in chronic malarial diseases, chronic catarrh, habitual constipation, and other allied affections, and will notice particularly a few of the new remedies which have been found of benefit in those affections.

Cascara Sagrado.—This is a shrub found in California, and introduced through the house of Parke, Davis & Co., of Detroit, Mich., by J. H. Bundy, M.D., of California. It is almost a specific in habitual constipation. Its action on the secretion and circulation is positive, and, without producing either nausea or other disturbances, it stimulates and improves digestion. Experience has demonstrated its action to be principally through the sympathetic nervous system, and especially the solar plexus. The reports of its use from a large number of physicians, and from different parts of the country, strongly confirm the statements of Dr Bundy as to the good results obtained by its use in habitual constipation, and it will doubtless take its place in our materia medica as a valuable therapeutical agent.

Grindelia Robusta.—One of the new remedies lately introduced east of the Rocky Mountains; has acquired a high place as a therapeutical agent in affections of the bronchials, especially in asthma. Its efficacy in these diseases has been so thoroughly established as to require no comment from me.

Grindelia Squarrosa.—Introduced as a remedy in chronic malarial diseases. It is recommended in enlargement of the spleen and lymphatic glands generally. Dr. Goss, of Georgia, considers it a valuable remedy in all affections of the glandular system, and advocates its use in leucæmia. It is given in twenty-drop doses of the fluid extract, three times a day.

Yerba Reuma.—This herb, Dr. Bundy says, grows near the foot hills of the coast range of mountains in California. It is of especial service as a remedy in nasal catarrh, leucorrhea, dysentery, gonorrhea, and, in fact, all affections of the mucous membranes. I have been using it in nasal catarrh with benefit, using of the fl. ext. ℥ j. to water ℥ viij., and snuffing up the nostrils three times daily.

Rhododendron Maximum (Deer Tongue, Laurel, or Great Laurel).—This shrub grows on the sides of the Alleghany Mountains. It was first brought to notice by Dr. J. M. Mulholland, of Pennsylvania. He uses it in obstinate coughs. It has been found to be of especial benefit in bronchitis and chronic catarrhal affections which have resisted all other remedies.

Yerba Santa.—Native of Mexico and California, with properties similar to the above, but said to have especial efficacy in the relief of chronic bronchitis of old persons. Its medical properties are astringent, tonic, demulcent, and balsamic. It is also employed in gastric catarrh, hemorrhoids, and chronic derangements of the kidneys.

Ustilago Maidis.—This drug is attracting considerable attention as a substitute for ergot. It is claimed that it is equal, and in some cases superior to ergot, producing clonic instead of tonic contractions of the uterus, and thus more nearly simulates natural labor. The testimony of a large number of physicians places it on the list of valuable oxytoxics. Its cost is about fifty per cent. less than that of ergot of rye.

Cereus Bonplandii.—One of the cactus family, introduced by Dr. Kunze, of New York. It is highly recommended in functional diseases of the heart, palpitation, etc. It has also been used in amaurosis with benefit. In Mexico it is used as a febrifuge.

Cereus Grandiflorus is a remedy similar to the above, and useful in a similar class of affections. Dr. J. M. Goss recommends it in five-drop doses to relieve the distressing palpitation in heart disease.—*New Preparations.*

GRAPES AS FOOD.

GRAPES may deservedly claim a high rank among the fruits as articles of diet, both in health and in sickness. They contain a considerable amount of hydrocarbonaceous matter, together with potassium salts—a combination which does not tend to irritate, but, on the contrary, to soothe the stomach, and which is consequently used with advantage even in dyspepsia. According to Dr. Hartsen, of Cannes, in France, who has recently contributed an article on the subject to a foreign medical journal, the organic acids in the grape, especially tartaric acid, deserve more consideration than they have generally received. Their nutritive value has, he thinks, been much underrated. It is known that they are changed to carbonic acid in the blood, and possibly careful research may show that they are convertible into fats. Dr. Hartsen thinks that they should be ranked with the carbo-hydrates as food. They have been found a valuable diet in fever, and the success of the "grape cures" in the Tyrol and other parts of Europe appears to show that they are positively beneficial in other diseases. No doubt the good results of a residence at these establishments are in a measure to be ascribed to the climate and the general hygienic discipline adopted. The advantage does not wholly consist in the fact that so many pounds of grapes are eaten daily, but partly in the fact that other less healthful things are not eaten; and pure air and exercise are also important elements in the curative treatment. But, after giving all due weight to these allied influences, we must allow no small fraction of the beneficial result to the grapes.

THE CAROLINA TWINS.

THE much-advertised "Carolina Twins" were recently subjected to a scientific examination at Prof. Wm. H. Pancoast's clinic at Jefferson Medical Hospital, Philadelphia. Before their entrance Dr. Pancoast read his memoranda of the examination of the twins, which he made about eight years ago. He considered the case a much more remarkable one than that of the Siamese Twins, who were two distinct persons, joined by a ligature only, whereas the Carolina colored women have but one backbone in common below the shoulder-blade. Above this point the spinal column branched like the arms of the letter Y. At their birth they were directly back to back, but as they were learning to walk they naturally twisted themselves considerably in order to facilitate locomotion. This change from their original relative positions it was possible to effect without injury or pain to either of them, owing to the softness and pliability of the bones in early youth. There was on record but one case that might be supposed to have been a parallel to that of the Carolina twins. This was that of the famous Hungarian sisters, who were born in 1701, and died in their twenty-second year. Their bond of union, though never scientifically determined, seemed to have been the same as that of the Carolina twins. They differed from the Carolina twins, however, in not possessing the same general characteristics.

Dr. Pancoast showed that if either of the twins were touched upon, or at any point below where the body was common to both, each of them would feel it, but that if he were to touch one of them above the point where the spinal column branched, the communication would reach only the

* See *Practitioner* for January.

† Clinical Medicine, vol. iv., p. 55.

brain of the one touched. He demonstrated, however, that the line was moving higher which divided their common from their separate and distinct nervous sensitiveness. Eight years ago a touch half an inch higher than the common part of the spine could be felt by both; but any farther up the sensitiveness was not shared by the person untouched. Now, however, it was proved by experiment that the common sensitiveness to a touch of the same character existed in either body at least two inches above the angle formed by the Y branches. Dr. Pancoast believes that the twins would die together.

FOOD REFORMS.

There is no doubt a great deal to be said in favor of a more scientific dietary, and properly qualified advisers are doing good service to ill-fed and dyspeptic humanity by pointing out the mistakes that are made in this respect. At the same time, it must be confessed that the discussions that have of late been so rife upon the subject present opinions of so varied and oftentimes so conflicting a character that ordinary persons, with no great aptitude for weighing scientific evidence and balancing authorities, must be sorely bewildered and perplexed. There is oatmeal, for instance, to which we have all been taught to attribute the real or imaginary physical superiority of Scotchmen, and which has lately been lauded to the skies as a bone-forming, brain-sustaining food. If that cannot be regarded with implicit confidence it is really difficult to say what there is in the way of cheap and simple food that may be trusted. Yet, if we turn to the analytical tables published a year or two ago by a famous German *savant*, we are assured that this vaunted food, cheap as it is, would be nearly as cheap again if it were appraised at merely its nutritive value. Taking its market value at 60, he says it would, if sold for what it was really worth as nourishing food, realize about 36, while a certain kind of animal food—calf's heart, that is to say—which weight for weight sells at about the same price, would, if similarly appraised, realize about 122. Of course, our vegetarian friends will indignantly scout such a statement as ridiculous. Yet it really seems to be about as trustworthy as the majority of the assertions with which this food discussion has been sustained, even those of them put forth by scientific men. This is but one instance of many that might be adduced tending to show the difficulty there is in arriving at satisfactory conclusions on this complicated subject, and which must lead a good many people to fall back in despair on the time-honored practice of selecting food according to the dictates of the palate, for which, after all, perhaps more is to be said than some of our food reformers appear to recognize—at least for those who can afford to follow this natural guide.—*Globe.*

THE "NEW DEPARTURE."—WHAT IT "BELIEVES" AND WHAT IT "CONTENDS."

By Henry S. Chase, D.D.S., M.D., St. Louis.

In proportion as teeth need saving, gold is the worst material to use for filling them.

In proportion as teeth are defective in organization or calcification, gold is the worst material to fill them with.

In proportion as teeth are bathed in acidulous saliva, gold is the worst material to put in them.

In proportion as patients are neglectful of their teeth, gold is the worst filling to have in them.

In proportion to the excessive use of acidulous beverages by persons having filled teeth, gold is the most dangerous filling there.

In proportion as teeth require large fillings, gold is the most dangerous metal to use.

In proportion as teeth are broken down, or have thin walls to their cavities, gold is the least useful for their preservation.

In proportion as teeth are decayed on their proximate surfaces, gold in the most dangerous of metals to fill them with.

It is often said of the "new departure" that "its theories may be true out of the mouth, but that they are not practically true in the mouth."

We contend that ordinary observation of the action of various fillings in the mouth most emphatically confirms the disputed theory.

We contend that metals having the best conducting power—electrically—are the least preservative of dentos.

We contend that experiments in the mouth supplement, with entire harmony, experiments that have been made out of the mouth.

We contend that the practice of nine-tenths of the dental profession is based on the secret belief that a gold filling will not preserve a badly-decayed tooth as well as an amalgam filling.

We contend that the present practice of the dental profession is based on the beauty of a filling instead of its usefulness.

We contend that gutta percha, tin, and amalgams all have a more favorable showing in the same mouth than gold has, so far as preservation of the teeth is concerned.

We contend that the most reputable operators fail to make as desirable operations with gold in proximate cavities as poorer (?) operators do with plastic materials under the same conditions.

We contend that it is not honorable for a dentist to subject a patient to a long and tedious operation, in order to produce results far inferior in usefulness to a short, simple, and easy operation.

We contend that it is the duty of every dentist to welcome the truth, however disagreeable it may be, and let consequences take care of themselves.—*Dental Cosmos.*

JAMES WATSON ROBBINS, M.D.

James W. Robbins, M.D., one of the most critical students of the botany of the Northern Atlantic States, died at Uxbridge, Mass., on the 9th of January, at the age of 77. Dr. Robbins was born at Colebrook, Conn., Nov. 18, 1801, graduated at Yale College in 1822, and taking his medical degree there, afterwards settled at Uxbridge in the practice of his profession. Dr. Bigelow excepted, he was the oldest botanist of New England, and perhaps the oldest in the United States, and within his range one of the most careful and accurate. He had an extended correspondence with all our American botanists, and was a colleague of William Oakes, who had the pleasure of naming in his honor several species of plants discovered by him. His collection extended not only throughout the New England States, but also through Virginia, and in Maryland (where he remained for several years when a young man), and on the shores of Lake Superior, where he spent four years. His attention, during the latter years of his life, was chiefly devoted to the study of aquatic flowering plants, in one difficult genus of which—*Potamogeton*—he was our best authority. The monograph of this genus in the last edition of Prof. Gray's "Manual of Botany" was from his pen. He it was who first detected in this country that simplest and minutest of flowering plants, the *Wolffia*.

In his death the country has lost one of its most earnest scientists, and his friends are called to mourn the loss of one who had endeared himself by his amiability and excellence.

JACOB BIGELOW, M.D., LL.D.

Jacob Bigelow, M.D., LL.D., widely known as a medical practitioner, botanist, and writer, since the beginning of the present century, died in Boston, Mass., on 10th January, aged 91 years. Dr. Bigelow was born in Sudbury, Mass., in 1787, graduated at Harvard University in 1806, and commenced the practice of medicine in Boston in 1810. He early became distinguished as a skillful botanist, and had a very extensive acquaintance with all the leading European authorities engaged in the study of that department of natural history. De Candolle, in France, named the genus *Bigelovia* in his honor, and different species of plants were named after him by Sir John E. Smith in England, and Schrader in Germany. In 1814 he published the "Florula Bostoniensis;" and in 1824 and 1840 he issued editions of this work, greatly enlarged by the addition of more recently detected plants. The "Florula" remained for many years a standard text book on American botany. In 1817 he published the "American Medical Botany," in three volumes octavo, illustrated with colored plates, drawn from nature. At this time he occupied the chair of Materia Medica in Harvard Medical College, and also that of Clinical Medicine; was an active practitioner of medicine in Boston for forty years, enjoying a large and lucrative practice; also for a long period physician to the Massachusetts General Hospital. From 1816 to 1827 he delivered lectures on the "Application of Science to the Useful Arts," which resulted in the establishment of the "Institute of Technology."

He had the reputation of an accomplished classical scholar, and was an occasional contributor to literary periodicals and reviews. He took great pride in his profession, regarding the vocation of the physician as a sacred one and the "noblest of all arts." He did not pursue it as a trade, for self-aggrandizement and wealth, but for the relief of suffering humanity. Since his retirement from active practice he had given much thought to matters of education, being specially interested in schools of technology, or such as give a technical or utilitarian education as contrasted with a classical or literary one. In the so called "new education," which aims to employ the time and labor of the student in the pursuit of special scientific branches, without wasting his energy on classical or other irrelevant studies, he was recognized as a pioneer. Dr. Bigelow was a man of very refined and artistic tastes, and all the sketches illustrating his beautiful botanical works were from his own drawings.

During the last years of a long and useful life his failing strength prevented exercise, and his loss of sight rendered him helpless, but his mental faculties retained a portion of their early vigor to within a short period of his death. His character, to use the words of one of his profession, "was one which it is a pride to record, a pleasure to recall, and a profit to imitate."

A NEW INDUSTRY.—FIG CULTURE AT THE NORTH A SUCCESS.

By G. F. Needham.

Some writer has said: "In a climate like ours any addition to the luxury of fruits should be studied. We cannot have many of the productions of the more southern climes, but by a little care we can have some that are seldom grown."

The vegetable world has been "studied," and the result is that most of our vegetables have been gathered from these tropical homes. I propose in this paper to study one of the tropical fruits, the fig, from both a theoretical and practical standpoint. And I make this emphatic statement that no other crop can be raised which will give so certain and so large returns in our Middle and Northern States as that delicious fruit, the fig.

1. The fig flourishes in much more unfavorable climates than our own. In Great Britain, for instance, figs have been grown in the open air for more than 300 years, the original trees brought from Italy by Cardinal Pole still bearing. Now, if in that damp, foggy, "misty, moisty" atmosphere, where melons and cucumbers cannot be grown, the fig will succeed, how much more will it flourish in our bright and sunny climate!

2. The climate of our north temperate zone is one of the best possible for the full development of the fig. It is a well-known fact that too great heat is inimical to this plant; it causes the tree to cast its fruit. Our northern climes are superior to the southern for another reason—our days are several hours longer than at the South, which gives a lengthened and tempered day, which precisely suits the fig.

3. Countries where figs are grown as an article of commerce are exposed to similar vicissitudes of climates as are our Northern States. I have before me a letter from a gentleman in Massachusetts, in which he says: "I was born in the Levant, and I was a resident in Constantinople one winter, when the Golden Horn (the Bosphorus) was frozen over, and there was a snow fall of 18 to 20 inches for a couple of weeks, without injury to the fig trees in the vicinity."

4. The reason that the fig yields so abundantly is not only that it is prolific, but, first, because the fruit has no insect enemies, and secondly, the wood has no blight or disease. Every other species of fruit trees gives the grower a world of trouble on account of these. Of these facts all are too well aware.

5. Common sense is quite as necessary in fig growing as elsewhere. A correspondent informs me that he has a "fig tree with 35 sprouts." What kind of an apple tree would that be? He would have to wait a long time for any apples, and then they would be "smaller by degrees and beautifully less." Cut off all the sprouts but one, and plant them, and "in the sweet by-and-by" you will have 35 trees.

6. The writer of a paper on the cultivation of the fig (Department of Agriculture, Special Report No. 4), speaking of fig raising in the Southern and Middle States, says: "There are few fruit trees, with so little trouble in their cultivation, that bear so abundantly or yield so much for so little care as the fig." Again, "The fruit is so great a luxury and so useful in so many ways, there is no reason why it should not become a very considerable article of commerce, and thus add to the wealth of the country."

7. If fig growing is so desirable for the Southern and Middle States, the testimony of Gen. Worthington is direct to the point, and makes sure the fact that fig growing is a success in our Northern States also. After years of cultivating the fig in Ohio, he says:

"It is quick grown, suits our climate admirably, is easily protected, is a sure bearer, and very prolific. The trees begin to bear when two years old, and when four or five they produce from the same area, with less labor, a greater and more certain crop than either potatoes or tomatoes. I like them best fresh from the tree, and often breakfast on them. The demand by the family is very great. The fig tree is eminently the fruit for the cottager and villager, and when its merits and adaptability to our climate become known, it will be as regularly grown for family use all over the Ohio Valley as either the potato or tomato."

And what is true of that State is true of the whole North.

8. In the Scriptures the vine and fig are very often mentioned in connection. (By the way, the fig will flourish where the vine grows.) And I ask that all my readers will join me in a very loud Laus Deo at the near approach of the promised good time (Micah iv., 1–4), when in our broad land, north and south, "they shall sit every man under his own vine and fig tree, and none shall make afraid;" because all enjoy their God-given rights.

11. Believing as I do that the general cultivation of this fruit will be so great a benefaction, and add so much to the comfort of the people, I am prompted to write this paper, that, if possible, I may induce some, without delay, to make a beginning in cultivating this unequaled fruit.

The *Ficus carica* of Linn. (belonging to the bread fruit family) is indigenous in Asia and Northern Africa.

With us it is a deciduous shrub, which can be propagated by cuttings as easily as the currant. It fruits when very young, and different varieties bear white, black, brown, green, blue, etc., fruit, which vary in size from a hickory nut to a Bartlett pear. The trees should be planted in a moderately rich soil. Too rich soil causes the tree to run to wood. By selecting suitable varieties the ripening season may be extended from July till frost.

PLANTING.

In the spring (at time of corn planting) throw up one or more ridges 8 feet wide and 16 inches high in the center. Stake off on the top of this, distances 10 feet apart. At these stakes dig holes at right angles to the ridges, say 2 feet long and 10 inches wide. Throw the top soil in a pile and throw the sub-soil away. Replace the soil in holes in the form of a mound 1 inch below the level in the center and 6 inches below at the ends. Then separate the roots into two parts. Set the trees at the center point, with the roots extending right and left down the mound. Fill up with any good soil and tread down thoroughly.

PROTECTING.

In the autumn, before danger from severe frost, prepare the trees for winter quarters, by cutting the roots growing lengthwise of the ridges with a sharp spade, not disturbing the original roots that were planted. Lay down the trees (lengthwise of the ridge), pegging down the branches that may need to be, then cover with earth, in this latitude, 2 inches deep. In that of Boston 4 inches deep. And no matter how old the trees, by this method of planting they are laid to rest very easily. Only with older trees, after the branches are pegged down, it will be best to fill in the interstices with leaves and then cover as before.

I think I hear an objection, "too much trouble." We do not hesitate to grow other luscious fruits on that account; and the necessity of winter protection will be atoned for from considerations before named. It cost about one cent each to protect the trees of my fig orchard this fall, a man and a boy laying down and covering over a hundred per day.

AFTER TREATMENT.

In the spring, at the time before noted, remove the earth from the trees and raise them to their positions. Thus it will be seen that the care of the trees is not great, and the whole operation is quite simple. The unripe figs that were buried with the wood will form the first crop of the next year.

HOW TO EAT FIGS.

In the East they seize the fruit in the left hand, with a knife cut off a thin slice from the large end, and then peel the fruit. Fresh figs and cream make a dish "fit to set before"—an "American sovereign." Fig preserves are also most delicious.

DRYING THE FRUIT.

The method is as follows: The fruit is put into baskets, which are dipped for two minutes in strong potash lye and then into clear water. The lye eats off the tough and gummy coating and improves the color of the fruit. The figs are then placed on hurdles and dried in the sun or by artificial heat, and when sufficiently soft to press closely they are packed in boxes.

ROOT PRUNING.

Should the soil be too rich it will be necessary to root prune the trees at time of laying down. This is done by cutting off with a sharp spade a portion of the original roots. The necessity of this will occur when the tree is woody and long-jointed.

HOME MADE SUPERPHOSPHATE.

Superphosphate of lime is a special fertilizer which may be used profitably on more soils and on a greater variety of crops than any other special fertilizer. Nearly all of our clay loams, as well as some lighter soils, are deficient in this element. Especially is it needed on most farms from which large quantities of milk, live stock or grain, have been sold. The habit which cows and young stock often form of chewing bones, leather, or boards, is a special indication of its deficiency in the soil on which they feed. The cheapest and best way to obtain superphosphate of lime is to purchase the materials, consisting of sulphuric acid and fine ground bone, using one carboy of about 175 lbs., 66° strength, to 500 lbs. of bone. Many newspaper men and scientific lecturers try to discourage farmers from making it themselves, telling them that it is better to buy it of phosphate dealers, but such advice helps to enrich the fertilizer men by increasing their business, but at the expense of the farmer. There is little danger or difficulty in the manufacture of it, if due care is used in handling the acid to avoid spilling it or spattering on the clothes or flesh. It is well to wear old woolen mittens, and over-clothes which are not very valuable, so if

you burn a few holes it will be but a small loss. If the acid is poured out with a steady hand, and quite slowly, it will seldom spatter. I am using one-half ton of fine steamed bone and two carboys of acid a year. I buy the bone from a local mill, where I can see it ground, and I know it to be pure.

I prefer steamed bone to any other form in which it is ground. It is better than raw bone, because it contains less water, is more soluble, and the grease, which is not a fertilizer, but is a damage, is also removed by steaming.

In a ton of dry steamed bone we get more pounds of phosphoric acid, and if it is not steamed too long, nearly as much nitrogen as in raw bone, while bone charcoal is entirely destitute of nitrogen.

In preparing superphosphate I use a round tub, two of which I make by dividing a molasses hogshead. This tub may not be as durable as Dr. Nichols' square box lined with lead, but it works as well, and a tub will last several years if properly cared for, and after washing and soaking it may be used for scalding hogs.

I put about 150 lbs., or three-fourths of a barrel of bone in the tub, then stir in water enough to moisten it well. I then apply the acid by pouring it out carefully into an earthen pitcher, which I keep for this purpose, which holds about three quarts or ten pounds. I measure or weigh out 70 lbs. of acid and apply to the bone, stirring it with each new addition, and after making sure that it is well mixed from the bottom, I leave it until the next day, and then stir in the remaining 50 lbs., or ¼ barrel of bone, adding more water if needed to mix well; after it has stood a short time, I shovel it out on the barn floor and mix with sawdust, or fine muck or other soil, occasionally shoveling it over and crushing the lumps until it is fine. If made early in the spring long before it is to be used, so as to give ample time to dry it, there will be no need of using a drier like saw dust, or muck, but it may be used pure and in smaller quantities.

The best result I ever obtained from superphosphate was from a lot I made several years ago, from Darling's fine steamed bone, and used it without any drier. I put only one-half tablespoonful of the pure dissolved bone in a hill for corn, and it went far ahead of corn planted beside it on a handful of hen manure in each hill, but I took much care to cover the phosphate with dirt before I dropped the seed, as it would surely have killed the corn if they had come in contact. It will be seen that I use 70 lbs. of acid to 200 of bone, but I apply all of the acid to three-fourths of the bone at first, so as to completely dissolve that much, and then mix in the remainder of the bone to take up any free acid which may be left in the mass. Probably 35 lbs. of acid to 100 of bone is not quite enough to render all the bone immediately soluble, and if a very quick action is wanted, it works better to use more of the acid, but this gives very good results, and what is not available at first will become so in time by the action of the elements in the soil. I usually apply the phosphate in the hill or drill, covering it with soil before dropping the seed. It is especially adapted to grain and root crops. But for squashes, melons, and cucumber vines, hen manure or guano would be better. For corn I apply the phosphate from 200 lbs. of bone per acre, which ought, if the bone is pure, to furnish soluble phosphoric acid enough for 50 lbs. of shelled corn, and if the land is good and has a fair dressing of stable manure spread on besides the superphosphate, it will give a good crop.—*J. W. Pierce, in N. E. Farmer.*

THE TORREY BOTANICAL CLUB.

At the regular monthly meeting of the Torrey Botanical Club, held in this city at the "Herbarium," Columbia College, Tuesday evening, March 11, there were fifteen members present.

Mr. W. H. Leggett read a communication from Professor D. C. Eaton containing a description, for publication in the Bulletin of the club, of a Hawaiian fern new to science. This beautiful little plant, a specimen of which accompanied the notice, was detected by the Hon. D. D. Baldwin in a little valley in Oahu at an elevation of 2,500 feet above the sea, where it was growing in great abundance. The fern is a species of *Hymenophyllum*, and in honor of its discoverer has been named by Prof. Eaton, *H. Baldwinii.* Mr. Baldwin, who is an enthusiastic collector of these plants, has also sent to Prof. Eaton specimens of another fern—*Trichomanes pyxidiferum*—a species entirely new to the flora of the Hawaiian islands.

Mr. Joseph Schrenk submitted a note sent him by Prof. Sachs, who had recently read the same before the Physico-Medical Society of Würzburg. Prof. Sachs, speaking of a number of species of the *Siphoneæ*, remarks that "these thallophytes, together with the *Mucorineæ*, are as yet considered as single-celled plants. He says that this view is correct, if by the term "cell" we understand a body which has originated by growth, and is surrounded by a cell membrane, and contains protoplasm. But as we can observe that the growth of the *Siphoneæ* and *Mucorineæ* is not accompanied by corresponding cell-divisions, as is the case with nearly all other plants, but takes place without any such divisions, it seems more natural to consider them as non-cellular plants—as plants whose interior space is not divided by septa, and whose protoplasm is not divided nor gathered around numerous centers. In this respect the cœloblasts without any nuclei (*Siphoneæ*, *Mucorineæ*, and others) differ materially from other so-called single-celled plants, such as *Desmideæ*, *Bacillariæ*, etc., the growth of which is accompanied by rhythmically repeated division; only with them the different compartments of the cell separate from one another at once, and live as "single-celled" plants.

Mr. Schrenk afterwards called attention to the fact that the specific name of *Anychia dichotoma* is a misnomer if the term "dichotomous" be taken in its present scientific signification. In older specimens of this plant, those found, say, in the latter part of July or August, the main stem and many of the branches are apparently truly bifurcated, but in younger plants we invariably find a flower terminating the growth of every axis, with a branch on each side from lateral buds. Hence this is a plain case of cymose, not of *dichotomous* ramification. This same fact is noted in the text-books; and it was urged, in the discussion that followed, that it was not unlikely that Michaux was aware of it likewise, but bestowed this name on the plant as the most fitting term that he could employ to designate its *apparent* "dichotomy;" and, moreover, that the specific names of plants were far from being, in all cases, *apropos.* Mr. Arthur Hallick read some notes on the "Abnormal Absence of Color in Plants." His remarks were embraced under two heads: (1) true albinos, or plants that have become white-flowered, spontaneously, in a state of nature, and (2) flowers which have been obtained thus by the art of the florist, through natural selection. As regards white-flowered varieties of wild plants, the author had detected the following on Staten Island: *Vernonia Noveboracensis*, *Lappa major*, *Lobelia syphilitica*, *Epiphegus virginiana*, *Verbena hastata*, *Asclepias incarnata*, *Trifolium pratense*, *Prunella vulgaris*, *Gentiana crinita*, and *Lobelia cardinalis.* In all these cases he had observed that the absence of the characteristic colors of the flowers was followed invariably by a slight tendency toward etiolation in the green parts of the plant, so that the changed appearance of the plant would strike the observer at once. The acrid or peculiar tasted juices of plants disappear more or less in the albino varieties of such plants. Darwin notes this fact, and says that honey bees are evidently aware of it, for they perforate the calices and corollas of white-flowered *Aconitum napellus*, to get at the honey, but will not touch the colored flowers. The author had experimented somewhat with *Lobelia syphilitica* to see if he could find a cause for the absence of color in the albino variety. He first detected the plants under the shade of some very thick underbrush. Thinking the absence of light might have had something to do with it, he watched for the plants next year when a clearing had been made, and the place exposed to the full rays of the sun. The plants, or their seedlings, again made their appearance at the same spot, and all were again of the white-flowered variety. To test the influence of the soil he transported some of the albino plants from a swampy place in which they grew to the dry soil of a garden, but still the seeds germinated and the plants produced white flowers as usual the next year. The author, in concluding, thought that perhaps an analysis of the ashes of albino plants might throw some light on the subject, by showing whether the presence or absence of color could be accounted for by a difference in the quality or quantity of elements absorbed by the plants.

[Note.—A chemical study of vegetable albinism has been made, quite recently, by Prof. Church, of England. He found that white leaves contain more water than corresponding green leaves, while the ash of white leaves contains more potash and phosphoric acid, but less lime, especially less oxalate and carbonate of calcium. Nearly 60 per cent. of nitrogen in the white leaves is non-albuminoid, while the green leaves contain 30 per cent. of nitrogen in that state. The leaves experimented on were gathered from the maple, holly, ivy, and three exotic plants; and the white and green leaves were in each case from the same plant, and of the same age.—Ed. Scientific American.]

Several members stated that they had found white-flowered varieties, also, of the following plants on Staten Island: *Sabbatia stellaris*, *Gerardia purpurea*, and *G. tenuifolia.*

Mr. Hallick reported that he had found the trailing arbutus (*Epigæa repens*) in full flower at Prince's Bay on March 1, of the present year. Mr. Hallick exhibited a specimen copy of a recently issued "Catalogue of the Plants of Staten Island," prepared under the joint authorship of himself and Mr. N. L. Britton.

MACKEREL.

Mr. Sherana Rich lately gave the Massachusetts Fish and Game Association the following statement of the history, statistics, and possibilities of the mackerel fishery of New England:

There have been inspected in Massachusetts alone, during the ten years preceding and including 1874, two million three hundred and sixteen thousand and eighty-three barrels, an average of two hundred and thirty-one thousand six hundred barrels annually. At an average price of twelve dollars and a half per barrel, which must be conceded a low estimate for these years, we have an annual product of about three millions from the salt mackerel department of Massachusetts. In 1850 Professor Storer estimated that about eight thousand barrels of fresh mackerel were sold in the Boston market. Since 1850, owing to increased facilities for transportation, and the general use of ice, this branch has been augmented in Boston at least tenfold. Immense quantities are carried direct to the New York market during the spring and early summer, counting which, and other places, it would seem a safe calculation that at least half as many mackerel are now sold fresh as are salt packed. Estimating their value the same as the salted fish, and allowing only half a million for all the mackerel caught in Maine and the other States, we have five million dollars annual income, to the industry of the State, on an outlay of thirteen millions. This five million is purely productive; every dollar comes from the ocean. Not even farming is so pre-eminently and entirely a productive industry. The fisherman plows an untaxed furrow that needs no replenishing year by year.

It is almost incredible how fast mackerel may be caught by a trained crew. The mackerel sometimes go up so fast that the whole side of the vessel shines like silver. In July, 1842, a crew of eleven men and boys "struck a school" of biting mackerel on George's Bank. In twenty-five minutes they caught thirty strike-barrels (a barrel so full that the live mackerel jump out). Ten hours such fishing would give six hundred strike-barrels, or about three hundred barrels, which, at the present price of that quality, would stock seven thousand five hundred dollars. Among leading mackerel fishermen, Skipper Richard Rich, of Truro, was a celebrity in his day. For many years he was "high line" in the country. On account of sailing many years in the schooner Osceola, he became quite widely known as "Osceola Dick;" some thought that mackerel knew him as well and came to his hook. One hundred and fifty wash-barrels was not a great deck for Osceola Dick. He has taken one hundred and ninety wash-barrels in a single day, all saved in good order, and without feeling very fishy.

In pursuit of food, mackerel roam the ocean as the beast roams the forests; but they move north or south by laws as fixed as the rule of the seasons. Thoreau, in his "Cape Cod," tells of a Wellfleet farmer who kept his schooner anchored in sight of his house, and while his corn and potatoes were growing, and at other odd times, with his boys, he ran down to Virginia and other points along the coast. Thoreau calls the schooner a market wagon, which this ocean farmer drove amain. As the farmer calls his flock by scattering corn, and thus leads them to fresh pastures and fields anew, so these sea-farmers call their flocks into the bays and on the banks of the coast, and feed with food convenient for them. In other words, the thousand or fifteen hundred sail of fishermen that used to fringe our shores, and by a systematic practice scatter a hundred thousand barrels annually of fat, fresh ground food to the mackerel, called "throwing bait," had educated the fish to visit, feed, and fatten in handy pastures.

I have stated that the average catch for the ten years ending with 1874 was two hundred and thirty-one thousand and six hundred barrels, and for the ten years ending with 1833 the average was two hundred and forty-seven thousand six hundred barrels—about sixteen thousand barrels more annually than in the last decade. In 1830 the population of the United States was less than thirteen millions; in 1874 it was over forty millions. The same ratio of consumption as in 1833 would require eight hundred and sixty-seven thousand in 1877—say one million of barrels. Our whole catch in the English and American waters of North America this season is not one-fifth of that quantity. Although the advantages of transportation have increased at a prodigious rate, yet the sales of mackerel have fallen off over three hundred and fifty per cent. per capita.

As we have taken so successfully to eating oatmeal, may we not take another lesson of the hardy Scotch, and learn to eat more fish? Surely if eating oatmeal and herring have given them brawn and brain, they may be proud of both. Dryden did not mean the Gaels when he said, "Brawn without brain is theirs." In 1860 there were employed in the Irish herring fisheries 57,000 men and boys, and more than fourteen thousand vessels and boats. The Dutch and Scandinavian fisheries are enormous, the fisheries of Norway being its leading business. In 1818 there were inspected in Massachusetts forty-seven thousand barrels of mackerel, which was the largest of any year in its history. It was regarded a good year for mackerel, and a great many wondered where all the mackerel went, and who ate them. In 1820 two hundred and thirty-six thousand barrels were inspected, and all found a ready market. In 1831 the returns were three hundred and eighty-three thousand barrels, and no complaints of any surplus stock. If any should think my standard of a million of barrels per annum a fancy estimate, let me call your attention again to figures. At the ratio of expansion during the thirteen years, from 1818 to 1831, we should need in 1890 nearly two millions of barrels. There need, then, be no doubt about the capacity of the country to consume all the mackerel that can be caught, however rapid the increase.

THE REPRODUCTION OF EELS.

At the eighth annual meeting of the American Fish Cultural Association, the President, Mr. Robt. B. Roosevelt followed up the account of the reproductive habits of eels begun at the last meeting of the association, when, for the first time, an announcement was made of the discovery of the eggs of the eel.

Mr. Roosevelt quoted a statement of Professor Baird to the effect that they matured their spawn in winter, when they are dormant and embedded in the mud, and when they could not unite with the male. It subsequently appeared that the parent eels had been caught in the fall of the year, when they were in full activity and in the fresh water preparatory to spawning. Mr. Roosevelt expressed an opinion that they were part of those taken by Mr. Aitkyns, in Maine—a locality in which it was probable that the eggs would mature earlier than with us, and at present there is no doubt about the truth of the discovery. The action of this society and the discussion before it attracted public attention to these fish, which for 2,000 years had been a stumbling block to the physiologists. Information came pouring in from all quarters, and although there was, as there always had been, much contradiction as to fact and opinion, important progress was made in our knowledge. The received theories of the descent of the mature fish to the sea in autumn to spawn and the ascent of the young in spring to the fresh waters were discredited, and if not disproved are now shown to be at least exceedingly doubtful, while their entire method of reproduction is freed from the strange theories which surrounded it. It is no longer supposed that eels are hermaphrodite—the two sexes united in one fish occurs only in the lower form of animal life—nor that they produce their young alive, nor that they have more than one heart in their bodies, although we have not yet ascertained accurately where and when they spawn; nor has an impregnated egg or a living spermatozoon been obtained. The presence of the eggs in the spawning fish was so apparent when the proper part was examined that it seemed impossible any difficulty could have ever arisen about it, and it now appears that many investigators knew of the existence of the eggs and had seen them frequently.

Notwithstanding these posthumous discoveries and assertions, to Mr. Aitkyns, Professor Baird, and especially to Mr. Eugene G. Blackford—who popularized the discovery in such a way that no one could doubt it—is due the credit of being the first persons who, in the course of 2,000 years of experiment, discovered the true procreative methods and organs of the eel. In winter eels lie dormant, if undisturbed, and conceal themselves in the mud, whether they happen to be in salt water or in fresh. Hibernation commences in November and continues until April. It would seem that the eggs are deposited in autumn. Mr. Aitkyns and many other gentlemen insist that spawning eels descend the rivers in the fall to the salt water, but it is probable that they are not descending, but merely seeking an appropriate place to spawn. Mr. Dyers holds that the eels ascend the streams in the fall in stormy weather, though Mr. Thomas Chalmers asserts that they descend in the fall while the water is muddy, and that the run stops when the water gets clear. Whether or not they breed in salt water, it is a fact that they also breed in fresh water. On Long Island, the young go down the stream in spring as soon as they are hatched. Absolutely mature eggs are yet to be found, although Mr. Blackford has found them in various conditions of maturity, and until eggs are found ripe for emission the exact time for spawning will not be known. No male eels—that is, eels containing milt—have yet been discovered. It has been suggested that the males may be much smaller than the females, and that there is a difference in their appearance. These suppositions, however, are not borne out by proof. There is one curious inconsistency about eels. Mature eels can be transported readily packed in barrels, and will live 24 or 48 hours without water. They are capable of great endurance treated in this way, although they will not live in stagnant ponds. But the young are exceedingly delicate, and cannot be carried any distance without frequent changes of water. They grow rapidly and feed freely on one another. Mr. Roosevelt had opened an eel of nine inches whose stomach was swelled out into a round protuberance by the number of little eels which it contained. The fry when they first appear are like white threads in the water, but in two weeks they are dark on the back and yellowish on the belly. The run of the fry on Long Island begins April 1 and ceases by May 24. Whatever contradictions exist as to the reproductive habits of eels, it is certain that a decided advance has been gained in knowledge relating to the subject. The eggs have been found, and it is known that they mature in the fall or winter, and that the young appear in the spring.

Note on the Phylloxera.—M. Carves.—The author maintains that the phylloxera *per se* is not the cause of the death of the vine, the real enemy being a fungus which plants itself in the wound made by the animal.

[Continued from SUPPLEMENT 170, page 2711.]

ARCHÆOLOGICAL EXPLORATIONS IN TENNESSEE.

By F. W. PUTNAM, Curator of the Peabody Museum.

THE chipped implements are of the several varieties of hornstone and jasper, of which the majority of such articles found in the Southern and Western States are made. They are of various sizes, patterns, and perfection of finish, such as are usually found together. One of the largest of these, which can be regarded as a knife, scraper, dagger, or spear point, as fancy may incline, is represented of natural size (Fig. 23). This was found in grave 15, with several other articles, as already mentioned. Two other large implements would be classed as scrapers. They are five inches long and from two to two and a half wide.

One of them is made from a piece of black hornstone which has an impure nodule on one side, that must have proved far less tractable to the worker than the rest of the stone, and may indicate that the scraper was used without a handle of wood, for the nodular part fits well to the palm of the hand and allows the opposite side to be freely used when so held.

The other scraper is made of a gray hornstone, and its highly polished edges and surfaces show that it had long been used, probably, simply as a hand stone.

A still ruder form of scraper, of the same material as the last, was found between the graves. This specimen is three and three-quarters inches in length by two and a quarter in width, and nearly an inch in its greatest thickness. It is as rudely made as many of the implements from the gravel bed at Trenton, described by Dr. Abbott, although of a material which is easily worked into delicate forms.

Another specimen, of a light mottled gray hornstone, is a well-made scraper with a beveled edge, and its size is such

FIG. 23.—CHIPPED IMPLEMENT, STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

as to suggest that it had been attached to a handle. It is two and three-quarters inches long, by one and a half across the beveled portion, the scraping edge of which is slightly convex. The opposite end of the implement is somewhat pointed and thinner at the edges.

From the scraper last described, the transition is easy to a small leaf-shaped implement of similar material, carefully chipped to a point and thin edges. This implement is an inch and three-quarters long, not exceeding in its greatest width three-quarters of an inch, flat on one surface, and having a ridge along the opposite center. While it might be classed as a leaf-shaped arrow point, it is more likely to have been mounted on a short handle for use as a knife, for which it is well adapted by its shape, point, and edges.

An implement of a gray hornstone, three and three-fourths inches long, one inch in width, and one-half an inch in thickness in the center, is interesting from its rather unusual shape, being pointed at both ends and decreasing in thickness in all directions from the center to the cutting edges. This was found in the dirt between the graves.

Passing to the spear points, knives, and arrow points, there are several of interest, a few of which were taken from the graves.

The largest of these is a well-made, symmetrical spear point, four inches long, one and three-fourths in greatest width, and one-fourth of an inch thick at its expanded base, which is perfectly straight and flat. The stem is slightly notched.

Another specimen, as long as the one just described, is somewhat thicker, but only one and one fourth inch wide. This has a narrow stem without side notches.

Ranging between these spear points and the small arrow heads, are ten perfect and several broken implements that may be classed either as spear points, knives, or arrow points. The largest of these, and the only one having an approach to barbs, is shown in Fig. 24, of actual size. As will be seen by the figure, this is not a symmetrical implement, and its shape is such as to suggest its use as a knife, or dagger point.

Two specimens are about half the size of the last; one of these has a perfect and delicate point, and is slightly notched

FIG. 24.—CHIPPED IMPLEMENT FROM STONE GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

on the sides of the stem. Seven others are of various sizes and widths, between two and one-half and three inches in length, and all have short, straight, or slightly notched stems. One of these is much thinner and broader, in proportion to its length than any of the others, and mounted on a handle would form a cutting instrument of no mean character.

Of three specimens, from an inch and a quarter to an inch and a half in length that were probably arrow points, one has a fine point, an expanded and slightly convex base, and a notched stem. Another has a straight stem and a proportionally longer and more slender point. The third is short and broad, with a convex base and that peculiarly shaped and abruptly made point which gives the impression that it was a broken specimen repointed.

Among the chipped implements of flint, was one that would probably be classed with the drills or perforators. This was found in a grave and is represented, of natural size, in Fig. 25.

Stone axes and celts have not often been found in the stone graves, though common among surface collections; and but two specimens were found in the three burial mounds explored under my direction, on Miss Bowling's farm. These are made of the same hard greenstone as the specimens obtained on Mr Overton's place, previously described, and resemble them in size, shape, and finish. The smallest is one inch thick, two inches wide, and three and one half long. The other is of the same thickness, but is one-half of an inch wider and longer. The lower half of these small axes has been ground and polished on both sides,

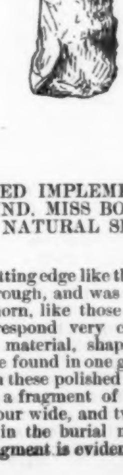


FIG. 25.—CHIPPED IMPLEMENT FROM STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

forming a central cutting edge like the modern steel ax. The opposite end is left rough, and was probably inserted into a socket of wood or horn, like those from the Swiss Lakes, some of which correspond very closely to the specimens from Tennessee in material, shape, and finish. Both of these specimens were found in one grave in the third mound.

In connection with these polished instruments of stone, it is of interest to note a fragment of fine grained sandstone, seven inches long, four wide, and two thick, which I found between the graves, in the burial mound here particularly referred to. This fragment is evidently a portion of a sharpening and polishing stone that had been long in use. Its opposite surfaces were concave and were worn so deep by long use that they had nearly come together, and to this fact the breakage of the stones at this particular point was due. On the sides and in the large concavity of one surface are small grooves and several deeply cut lines, formed by rubbing implements of different kinds on the stone. As will be inferred, this is a very interesting specimen, illustrating the method of polishing stone implements, and with the three rings, probably as important as any obtained from this mound.

A water-worn stone, six inches long, of oval form, was found in the second mound, and is of interest as furnishing conclusive evidence of the use of natural forms for the vari-

FIG. 27. FIG. 26.

FIG. 26.—IMPLEMENT OF BONE, STONE GRAVE-MOUND, MISS BOWLING'S FARM. HALF SIZE.

FIG. 27.—IMPLEMENT OF BONE, STONE GRAVE-MOUND, MISS BOWLING'S FARM. HALF SIZE.

ous purposes to which they may have been adapted. The stone in question is highly polished on one portion of its surface, and by holding it in the hand in the easiest manner, its adaptation for various rubbing purposes, which would cause the polishing of the particular portion showing use, is readily perceived.

Among the articles found between the graves in the mound was the half of one of the thin, flat stones with two holes, which are generally classed as personal ornaments.

In mound 2, three discoidal, or "chungke" stones were found. One of these is made of white quartz, highly polished, and is three inches in diameter. Another, about half an inch greater in diameter, is made of a compact gray sandstone, and shows signs of rough usage on its fractured edge. The third is three inches in diameter, one and one-half thick, and is biconcave. The material is rather coarse, hard sandstone.

Near the ash bed, which I have already mentioned as having been found under the lower tier of graves, north of the center of the mound, was found a fragment of talcose slate, that probably once formed a portion of a cooking utensil of some kind, perhaps a large vessel, or possibly a baking stone, like those found in the shell heaps of California. It is a well-worked piece of stone, of nearly an equal thickness of about an inch, and slightly smoother on

FIG. 28.—POINTED BONE, STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

one surface, which is a little convex, than on the other. Near one edge there is a hole three-eighths of an inch in diameter. A careful search was made for other portions of this utensil, but only this was found, and its weathered edges show it to have been a fragment when left near the ancient fireplace.

A small mass of burnt clay, containing the impression of several reeds which had been placed parallel to each other, was also found in the bed of ashes.

Implements made of bones of animals have been found among the remains of prehistoric races in various parts of the world, and the graves, mounds, and shell heaps of Ame-

rica have furnished many examples of the typical forms. Pointed implements made from the leg bones of animals, particularly of the metatarsal bones of various species of deer, are the most common forms, and specimens from the mounds and stone graves of Tennessee are identical in shape and finish with those from the Swiss Lake dwellings.

One of these large implements, here shown (Fig. 26), of one half its diameter, was found in one of the graves in the first mound explored on Miss Bowling's farm.

Other implements for like use were made from the antlers of deer, and two such were found in grave 15, which, as already mentioned, contained numerous articles. Another similar and pointed tool, made from the leg bone of a large bird, was found in another of the graves of the same mound.

Splinters of bone were also utilized as awls and needles. Two such, six and seven inches in length, and looking like knitting needles, were found in grave 25. These were pro-

Fig. 29.—TOOTH OF A BEAR, STONE-GRAVE MOUND, MISS BOWLING'S FARM. NATURAL SIZE.

bably made from pieces cut from the metatarsus of a deer and then polished and pointed. The smaller of these has a slight groove cut around the large end, as if for fastening a thread. The other, which is shown in Fig. 27, of one-half its length, is smooth and highly polished over its whole surface.

Among the articles found in grave 15 were six small splinters of bone, which have been carefully pointed at one end, and, in those that are perfect, the opposite end is notched as shown in Fig. 28, representing a perfect specimen of its actual size. These small bones were found close to the skull, and I believe them to have formed part of a hair comb, from this fact and from their close resemblance to the teeth of combs found in the graves in Peru, and their still greater resemblance to the wooden teeth in the hair comb once belonging to the famous Modoc, Capt. Jack, and now in the Museum. This view was further substantiated by the discovery, afterward, in a grave at Lebanon, of several similar pieces of bone, also by the side of a skull.

Several other bones were found in the graves of mound 1, but with the exception of two wing bones of a large bird, which may have been whistles, there was nothing to indicate that they were intended for special purposes.

Several teeth were also found, among them one of a large rodent, and two canines, probably of a young bear, which were perforated, and as they were found with a number of beads made of shell, near the neck of the skeleton, it is very likely that they formed part of a necklace. One of these teeth is figured (Fig. 29). Several shells of turtles (*Cistudo*) were found in the graves, and though they do not show any signs of particular use, they may have been rattles, similar to those known to have been used by some of the Southern tribes and still common among the Indians.

Of articles made of shells several forms occurred in the graves in this mound, the most common being the spoons made of the valves of *Unio*. These spoons, as will be seen by the illustration (Fig. 30) were very convenient and useful domestic articles. Many of them were found in the graves, and generally in such vessels as food would naturally be placed in, but owing to the decay of the thin shell few could be handled without crumbling into chalky particles. Six were, however, saved from the graves in mound 1, and several others were collected afterward in different localities. All of those from the graves in the mound were made from the right valves of the muscles, and indicate righthandedness, as the rule, with this people. They were made by cutting away the thick portion of the shell along the hinge, and also the thin portion of the lip. The shell was then further cut away on its upper part, leaving the projecting handle as shown in the figure, which, from the position in which the spoon was placed by the artist, does not convey as good an idea of the thing itself as would be the case if the drawing had been reversed, and the handle part of the spoon placed in the right lower corner. This would bring the valve of the shell in its natural position, and also show the spoon in its most convenient position for use in the right hand. In some specimens the handle is not rounded and smoothly cut, as in the one figured, but it is deeply notched on its outer edge as if for ornament.

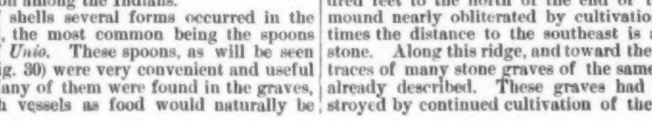


Fig. 30.—SPOON MADE FROM SHELL OF UNIO, STONE-GRAVE MOUND. NATURAL SIZE

Many natural valves of several species of *Unionidæ* were found in the grave, sometimes in the same grave with one or more spoons. Several other shells in natural condition were also found in the graves. The most numerous of these were two species of *Melania*, and one or two other species of fluviatile shells common in th State, and, of course, they must have been purposely deposited within the graves, while several specimens of *Helix* were undoubtedly living intruders.

In one grave, near the head, were several hundred specimens of the little *Olivella*, identified by Prof. Hamlin of the Zoological Museum as *O. mutica*, Say, of the Southern Atlantic coast. Every one of these little shells, which are not much over a quarter of an inch in length, has the apex ground off, thus making a hole through the shell by which it could be strung, the whole lot in question probably having once formed a necklace or head ornament, of great value to its owner. The occurrence of this and other marine shells is another indication of intertribal intercourse, or of extensive wanderings on the part of this ancient people.

In three other graves in this mound, beads made from marine shells were found. These beads were the same as those obtained from the mounds throughout the country, and have been cut principally from large marine shells, such as *Strombus*, *Busycon*, etc. Many of the beads in this mound were very much decayed. Those that were collected are of three forms.

In the grave in which the perforated bear's teeth were found was one large oval, symmetrical bead, three-quarters of an inch long by one-half an inch in diameter. About one hundred other smaller, well-finished beads, with a diameter of about a quarter of an inch and a length of about two-thirds the diameter, formed the rest of what I believe was a necklace, which we could probably reconstruct by placing the large bead and the two bear's teeth in the center, with the small rounded beads on each side.

In another grave, in which were several common fresh-water shells, were also a number of beads very much decayed, but about twenty were saved. These are of two kinds, a small, rounded form, about a third of an inch long, and a flat bead, having a thickness of not over an eighth of an inch, and a diameter of about one-half an inch. In another grave was found a single bead like the last described.

In closing this account of the contents of the mound, I must reiterate that not a single article was found indicating contact with any other people than different tribes belonging to their own race, and the same applies to all the other mounds of this important group on Miss Bowling's farm.

Having a desire to make an examination of one of the large mounds, of which there are many still remaining in the Cumberland valley, I accepted the invitation of the Rev. M. A. Matthews to explore one on land belonging to the family of Mrs. Matthews, and known, from the name of the family, as the Love Mound.

This large mound is 23 feet high, and, as near as the measurements could be made, owing to the washing of the banks, 155 feet in diameter in a north-south line, and 147 feet in an east-west direction. It is located near the East Fork of White Creek, which flows in a southwestern direction to the Cumberland, entering that river about six miles distant in an air line.

In the immediate vicinity of the mound, on the north, west, and south are large artificial depressions, showing where the earth forming the mound was obtained. The excavations on the north and south have left a slight ridge, about a hundred feet in width and several hundred feet in length, to the eastward of the mound. About two hundred feet to the north of the end of this ridge is a small mound nearly obliterated by cultivation, and about three times the distance to the southeast is an outcrop of limestone. Along this ridge, and toward the limestone ledge, are traces of many stone graves of the same character as those already described. These graves had nearly all been destroyed by continued cultivation of the land, and I found but one that had not been disturbed. This grave was 6 feet long, 22 inches wide, and 18 inches deep. The body had been placed in the grave with the head to the west. The skeleton was so far decayed that only a few of the bones could be saved, and the only article found in the grave was a portion of an ear ornament in contact with the side of the skull. This eardrop was made of a piece of wood covered with a thin layer of copper.

An excavation was made in the center of the small mound, but nothing was discovered except the indications of a fire a few feet from what is now the surface of the mound.

The large mound was a landmark at the settlement of the place, in 1795, by Joseph Love, the grandfather of Mrs. Matthews, and its summit has been used as a family cemetery, which somewhat interfered with the work of exploration.

In 1795, Mr. Love, as reliable family tradition states, "found a heavy growth of timber on the mound, and decayed stumps of red oak trees that were over two feet in diameter." Twenty-five years ago the mound was cleared of timber with the view of cultivating the sides, but as they were found to be too steep, it was again left to nature. The trees which cover the mound at present are, therefore, less than twenty-five years of age.

Four days, with six to eight men each day, were given to the exploration of this mound, in the following manner: A trench, 4 feet wide and 44 feet in length, was cut on the southern side of the mound in its central portion, and running east and west. This trench was dug to the depth of 10 feet. Two other trenches, 15 feet apart, of the same width as the first, were then started from the first trench. The westernmost of these was carried 11 feet directly north, so as to reach as near the center of the mound as possible, without disturbing the several graves on the summit. The other trench was carried 16 feet in a northwesterly direction, the two trenches terminating between 10 and 11 feet apart. These two trenches were dug to a depth of 23 feet, when the original black soil was reached, upon which the mound was erected. At the bottom and ends of these trenches tunnels were started so as to reach the center of the mound. Eight feet in length was thus added to the trenches, and from these tunnels, auger borings, three feet in length, were made in all directions without meeting with the slightest indication of a central chamber or relic of any kind. As it seemed useless to continue the exploration, the trenches were filled and the mound restored to its former shape.

The earth of which this mound was composed had been brought in small quantities, probably in baskets, and the outline of each little load could be distinctly seen on the sides of the trenches. This earth had, through the long period of time that must have elapsed since the mound was erected, become dry and compact and nearly as hard as sandstone. It was, therefore, necessary to loosen it by the pick, and much was thrown from the trenches in lumps by the workmen. The fineness of the material, and its freedom from stones and pebbles, were noticed by all at work, and it appeared as if the earth had been carefully sifted before it was placed on the mound. In the nearly five hundred cubic yards of earth removed from the trenches, only the following extraneous things were found. In the long trench, at the depth of 3 and 5 feet, two small fragments of cannel coal, and at the depth of 5 and 6 feet, two small pieces of greatly decomposed limestone. In the two trenches diverging from the one first made, and at depths of 3, 5, and 8 feet, four small pieces of limestone and a fragment of flint were found. At 14 feet a piece of the shell of a *Unio* was discovered, while three or four flint chips and as many minute pieces of sand and limestone were thrown out at various depths. In the trenches near the center, at a depth of 13 feet, were found three slabs of decomposed limestone, each of about 12 by 18 inches and 1 inch in thickness. The position in which these stones were found was such as to indicate that they were part of a circle of stones around the center of the mound when it had reached the height of 10 feet. The decayed condition of these slabs of limestone and the formation, on the under side of each, of a thick scale of red oxide of iron are indications of the great age of the mound itself.

The results of the exploration of this mound lead to the supposition that it was erected for some other purpose than as a monument over the remains of the dead, and, as the remains of numerous graves near it indicate a settlement at this place, it is very likely that it was devoted to some other important purpose of the people of the town.

(To be continued.)

ON THE RECENT ERUPTION AND PRESENT CONDITION OF VESUVIUS.*

At the end of the great eruption of 1872 the crater of Vesuvius was left as a wide and deep abyss, the floor of which did not possess a very high temperature, and was free from fumarole. Gradually, however, fumarole appeared, the temperature increased, and large quantities of steam and carbonic acid were evolved. The temperature continued to increase and sulphurous acid made its appearance; finally in 1875 the evolution of carbonic acid diminished, and that of hydrochloric acid commenced. This is always the commencement of the highest stage of fumarole activity. In January, 1875, when I ascended the mountain, large quantities of sulphurous acid were being evolved, and it was quite impossible to descend into the crater. On December 18, 1875, a deep chasm opened in the bottom of the crater, at the bottom of which glowing lava could be seen. This was the commencement of a new period of eruption, which Palmieri predicted would last a long time, and which is still going on. The lava gradually rose to the top of the chasm, and a new eruptive cone soon afterward formed on the floor of the great crater. Small quantities of lava issued from time to time from the new cone, and spread over the interior of the crater, until on the night of November 1, 1878, it rose to the lowest portion of the edge of the crater, and began to flow down the great cone of Vesuvius in a northwesterly direction. The lava continued to flow in a somewhat intermittent manner until nearly the end of the year, but it did not go beyond the foot of the cone.

On December 29 last I visited the new cone. I left Naples at 8.45 A.M., drove to Portici, and walked to Resina. Left Resina on foot at 10 A.M., came upon the lava of 1451 (according to the guide, but I suspect it was lava of 1631) at 10.30, then bore somewhat to the west, and struck the lava of 1858. Reached the observatory at 11.15 A.M., the foot of the cone at 11.45, and the summit of the cone at 12.40 P.M. Thus the ascent of the cone occupied fifty-five minutes, including about ten minutes of rest. The angle is approximately 32°, and the ash of which the cone is composed is very loose. On arriving at the summit we turned to the west, and walked along the edge of the great crater until we came to its southwestern extremity, beyond which it is broken down by the recent flow of lava. Then we descended the crater by a very precipitous path, and presently found ourselves upon the new lava, surrounded on three sides by precipitous walls of apparently not more than 100 feet in height. Facing due northeast, we had on our right the new cone of November, 1878, and on our left the stream of lava which had issued from it, and which was still very hot, and in some places could be seen to be red hot a little distance beneath the surface. Occasionally a puff of very hot air was blown into our faces from the hotter portions of the lava. In many places hot fumes of hydrochloric acid escaped from

* *Nature.*

the lava, and great cavities (in one or two cases small caverns), from whence the hot acid vapors issued, were coated with brilliant red and yellow sublimates of sesquichloride of iron. These sublimates are constantly spoken of as sulphur. I am inclined to assert that in more than ninety-nine cases out of a hundred they are sesquichloride of iron formed either by direct sublimation of previously formed chloride from lower recesses in the lava bed, or by the action taking place then and there of the hot hydrochloric acid upon the exposed surfaces of the lava. Sublimations of salt were also apparent in certain portions of the lava bed. Prof. Palmieri informs me that he has detected sulphates in the sublimates, also lithium and boracic acid. I have not yet had time to examine various specimens of sublimates, which were collected from the new lava, and were placed in a dry bottle as soon as I reached Naples.

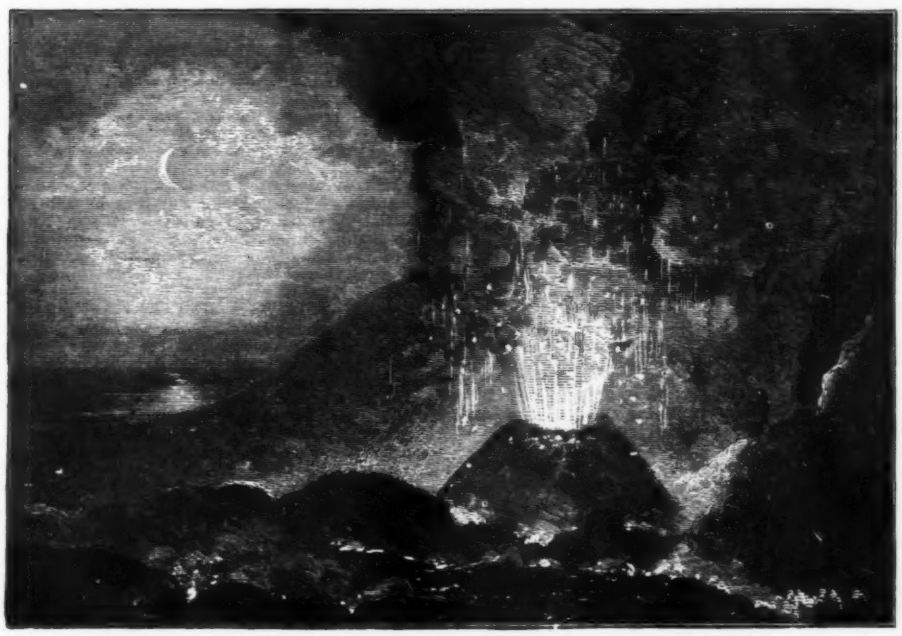
Prof. Palmieri has kindly furnished me with a MS. account of "Il Vesuvio dopo la grande eruzione del 1872," from which some of the above facts were derived. My own recent experience on the mountain does not, however, allow me to agree with him when he says: "Comunque sia, in tutto il tempo trascorso il cratere ha di mostrato poca attivita dinamica. Pochi brani di lava gettati fino all' altezza di 20 o 30 metri, soffi piu o meno vigorosi e qualche rara detonazione han rappresentato il vigore della forza eruttiva." The new cone, when I saw it, was pouring out vast volumes of smoke and steam, detonations occurred at frequent intervals, and loud noises as if of the lava surging within the crater. At intervals, also, the smoke was intensely illuminated, as if the lava had leaped up within the cone. The cone discharged a perpetual shower of red-hot pieces of lava of a more or less cindery character, and certainly to a height far exceeding the "20 o 30 metri" of Prof. Palmieri. It is difficult to judge of heights under such circumstances, but many of the fragments appeared to be projected to a height equal to that of an ordinary skyrocket. The ejected masses nearly all fell on one side of the cone and helped to raised it. Occasionally, however, a sudden burst would come which scattered the red-hot masses in all directions. We approached as near as we could to the cone, and stood upon the bank of cinders (*vide* the accompanying woodcut) in immediate contact with it, and not a dozen yards from its vomiting crater. Showers of red-hot stones were projected from the crater, many of which fell into it again, and the rest for the most part on the side remote from us. There came a sudden burst, however, which shook the ground under our feet and scattered red-hot masses in all directions. A piece weighing four ounces fell within six feet of where I was standing, and the guide ran up to it and pressed a copper coin upon its still soft surface. A few minutes later a piece of red-hot lava, weighing at least seven times as much as the preceding, fell within four feet of me, and I promptly retired to a safer distance. Fifteen days before a guide had been killed by a falling red-hot stone from the crater. The projectiles from the crater are doubly dangerous, because you cannot "dodge" them. They do not come down straight like a cricket ball, but waver in their flight like a boomerang. In the case of the larger of the two masses which fell so near to me, I had not only time before it fell to watch it in the air above my head, but also to speculate as to where it would fall. Judging by its position when about forty feet from the ground, it would certainly, I thought, fall behind me; a moment later it swerved, and fell about four feet in front of me. The cone, with its lurid smoke, and loud detonations, and showers of red-hot stones, presented a most fascinating spectacle. What, then, must be the effect when the whole great cone of Vesuvius is in a like condition?

The new lava is very leucitic, and does not resemble that of 1872. When in a viscous state it can easily be drawn into threads, and when cold it is jet-black and possesses a fine luster.

Chloride of ammonium does not appear to have been at all a common product in this eruption, although it was conspicuously present during the eruption of 1872. Great differences of opinion still exist as to the formation of sublimates of chloride of ammonium in lavas. Bunsen considers that it is mainly formed by the action of the hot lava upon vegetable soil, and he has proved that "a square meter of meadow land yields on dry distillation a quantity of ammonia corresponding to 223·3 grammes of chloride of ammonium." Palmieri, while he admits that he has found more chloride of ammonium in those portions of lavas which have passed over cultivated ground, asserts that he has also found it high upon Vesuvius far above the range of vegetation, and in localities where the new lava has simply flowed over older and perfectly barren lava fields. He accounts for its formation by supposing that aqueous vapor undergoes dissociation in the heated crevices of the lava, and that the nascent hydrogen combines with the nitrogen of the air to form ammonia. We do not know what chemists will have to say to this theory.

Not far from the active cone I found a very interesting specimen of volcanic cinder, which had obviously been exposed to the action of hydrochloric acid at a very elevated temperature, and had then probably been ejected before the action was complete. The central portions consisted of undecomposed cinder, and this was surrounded by a thick layer of perfectly white decomposed substance, consisting chiefly of silicate of alumina and silica; the hot hydrochloric acid having formed sesquichloride of iron with the iron in the superficial layers of the mass, which sesquichloride had been afterward volatilized out of the mass. By passing hydrochloric acid over lava heated to redness in a porcelain tube, the same effect was produced, the portions of lava most strongly heated and longest submitted to the action of the hydrochloric acid became perfectly white, while a copious sublimate of chloride of iron and chloride of aluminum passed into the receiver.

I ascended from the new lava (viz., from the bottom of the great crater of Vesuvius, *vide* the foreground of the accompanying woodcut) at 1.30 P.M., ran down the sides of the great cone, which had taken fifty-five minutes to climb, in seven minutes, reached the observatory at 2.30 P.M.; Portici, by a roundabout way to the west near Monte Somma, whither we went to search for minerals, at 4.30 P.M.; and Naples at 5.40. The next evening, while steaming out of the bay, *en route* for Tunis, I noticed that the smoke at the apex of the mountain was ruddy from the reflection of the lava within the small crater of 1878, and then for many days after the summit of the mountain was obscured by clouds, and snow lay upon it when I next saw it toward the middle of last January. G. F. RODWELL.



THE NEW ERUPTIVE CONE AT MOUNT VESUVIUS.

SANDSTONE IN COAL.

PROF. L. E. HICKS has discovered a bowlder of hard, gritty sandstone, ten inches in diameter, in a seam of coal at New Straitsville, Ohio. Two other similar geological puzzles are on record. Prof. E. B. Andrews notices a large quartzite bowlder, which had been turned up from the Nelsonville seam at Zaleski, Vinton County. He attributes its transportation from the margin of the sort of sea in which the coal was formed to the position it occupied at the time it was excavated, to floating ice. Prof. J. S. Newberry, speaking of the talcose slate bowlder, found in a coal seam in Wyoming County, thinks it was brought there by being entangled in the roots of trees, and thus floated and dropped. —*Detroit Free Press.*

ON SOME PHYSICAL PROPERTIES OF ICE; ON THE TRANSPOSITION OF BOWLDERS FROM BELOW TO ABOVE THE ICE; AND ON MAMMOTH REMAINS.

By JOHN RAE, M.D., LL.D., F.R.G.S., etc., Gold Medalist of Geographical Society.*

Is the ice formed on salt water fresh? or, in other words, if ice formed on the sea is thawed, will the water obtained thereby be fresh?

For a number of years past I have spoken with many persons on the subject, and seldom, if ever, have I found a single individual who did not say that the ice of the sea was fresh.

Some of these gentlemen are known in the scientific world; and many of them supported their opinions by quoting the highest written authorities on the subject, chiefly Tyndall's "Forms of Water," p. 132, par. 339, which tells us that "even when water is saturated with salt, the crystallizing force studiously rejects the salt, and devotes itself to the congelation of the water alone. *Hence the ice of sea water, when melted, produces fresh water.*"

It is the sentence in italics to which I wish to draw particular attention.

It would be the extreme of folly and presumption on my part to question the correctness of results obtained by scientific men in their experiments in freezing small quantities of sea water by artificial means, more especially those of the distinguished gentleman whose name I have mentioned, who, in addition to holding the high position of being one of our greatest authorities in all that relates to physical science, possesses the rare gift of being able to communicate his knowledge in such plain, clear, and forcible language, illustrated by admirable experiments, as to make his meaning fully understood, even by those who had previously been perfectly ignorant of the subject.

It is only where I have had opportunities of witnessing the action of cold carried on in a manner which may have been denied to the scientific man, that I venture to differ from him; and it is in this way that the conviction has been forced upon me, that the ice of sea water if melted does *not* produce fresh water.

Before entering upon this subject, however, let me say a word or two on the first part of the quotation I have given.

If a saturated solution of salt is frozen, and the ice so formed is fresh, it is evident that the salt that has been "rejected" must be deposited or precipitated in a crystalline or some other solid form, because the water, if any, that remains unfrozen, being already saturated, can hold in solution no more salt than it already contains.

Could not salt be obtained readily and cheaply by this means from sea water in cold climates?

During several long journeys on the Arctic coast, in the early spring before any thaw had taken place, the only water to be obtained was by melting snow or ice. By experience I found that a kettleful of water could be obtained by thawing ice with a much less expenditure of fuel, and in a shorter time, than was required to obtain a similar quantity of water by thawing snow. Now, as we had to carry our fuel with us, this saving of fuel and of time was an important consideration, and we always endeavored to get the ice for this purpose. We had another inducement to test the sea ice frequently as to its freshness or the reverse.

I presume that almost every one knows that to eat snow when it is very cold tends to increase thirst, whereas a piece of ice in the mouth is refreshing and beneficial, however cold it may be; we were consequently always glad to get a bit of fresh ice while at the laborious work of hauling our heavy sledges; yet with these strong inducements we were never able to find sea ice, *in situ*,* either eatable when solid or drinkable when thawed, it being invariably much too salt. The only exception (if it may be called one) to this rule, was when we found rough ice, which, from its wasted appearance and irregular form, had evidently been the formation of a previous winter. This old ice, if projecting a foot or two above the water level, was almost invariably fresh, and, when thawed, gave excellent drinking water. It may be said that these pieces of fresh ice were fragments of glaciers or icebergs; but this could not be so, as they were found where neither glaciers nor icebergs are ever seen.

How is this to be accounted for? Unfortunately I have only a theory to offer in explanation.

When the sea freezes by the abstraction of heat from its surface, I do not think that the saline matter, although retained in and incorporated with the ice, assumes the solid state, unless the cold is very intense, but that it remains fluid in the form of a very strong brine inclosed in very minute cells. So long as the ice continues to float at the same level, or nearly the same level, as the sea, this brine remains; but when the ice is raised a little above the water level, the brine, by its greater specific gravity, and probably by some solvent quality acting on the ice, gradually drains off from the ice so raised; and the small cells, by connecting with one another downward, become channels of drainage.

There may be several other requisites for this change of salt ice into fresh, such as temperature raised to the freezing point, so as to enable the brine to work out the cell walls into channels or tubes—that is, if my theory has any foundation in fact, which may be easily tested by any expedition passing one or more winters on the Arctic, or by any one living where ice of considerable thickness is formed on the sea, such as some parts of Norway.

All that is required, as soon as the winter has advanced far enough for the purpose, is to cut out a block of sea ice (taking care not to be near the outflow of any fresh water stream) about 3 feet square, remove it from the sea to some convenient position, test its saltness at the time, and at intervals repeat the testing both on its upper and lower surfaces, and observe the drainage if any.

The result of the above experiment, even if continued for a long while, may not be satisfactory, because the fresh ice that I have described must have been formed at least twelve months, perhaps eighteen months, before.

THE TRANSPOSITION OF BOWLDERS FROM BELOW TO ABOVE THE ICE.

When bowlders, small stones, sand, gravel, etc., are found lying on sea ice, it is very generally supposed that they must have rolled down a steep place or fallen from a cliff, or been deposited by a flow of water from a river or other source. There is, however, another way in which bowlders, etc., get upon floe ice, which I have not seen mentioned in any book on the subject.

During the spring of 1847, at Repulse Bay, on the Arctic shores of America, I was surprised to observe, after the thaw commenced, that large bowlders (some of them 3 or 4 feet in diameter) began to appear on the surface of the ice; and, after a while, about the month of July, they were wholly exposed, while the ice below them was strong, firm, and something like 4 feet thick.†

On the shores of Repulse Bay the rise and fall of the tide is 6 or 8 feet, sometimes more. When the ice is forming in early winter, it rests, when the tide is out, on any bowlders, etc., that may be at or near low water mark. At first, while the ice is weak, the bowlders break through it; but when the ice becomes (say 2 or 3 feet) thick, it freezes firmly to the bowlder, and when the tide rises, is strong enough to lift the bowlder with it. Thus, once fastened to the ice, the stone continues to rise and fall with the rise and fall of each tide, until, as the winter advances, it becomes completely inclosed in the ice, which, by measurement, I found to attain a thickness of more than 8 feet.

Small stones, gravel, sand, and shells may be fixed in the ice in the same way.

In the spring, by the double effect of thaw and evaporation, the upper surface of the ice, to the extent of 3 feet or more, is removed, and thus the bowlders, which in autumn were lying at the bottom of the sea, are now on the ice, while it is still strong and thick enough to travel with its load, before favorable winds and currents, to a great distance.

The finding small stones and gravel on ice out at sea does not always prove that such ice has been near the shore at some time or other.

I have noticed that wherever the walrus in any numbers have been for some time lying either on ice or rocks, a

* Read before the Physical Society, May 9, 1874.

* What I mean by ice *in situ* is ice lying flat and unbroken on the sea, as found during the winter it is formed in.

† There were no cliffs or steep banks near, from which these bowlders could have come, and the only way in which I could account for their appearance was that which by subsequent observation I found to be correct.

not inconsiderable quantity of gravel has been deposited, apparently a portion of the excreta of that animal, having probably been taken up from the bottom of the sea and swallowed along with their food.

MAMMOTH REMAINS—THE POSITION IN WHICH THEIR SKELETONS ARE FOUND, ETC.

In Lyell's "Principles of Geology," vol. I., p. 185, we read "In the flat country near the mouth of the Yenesei River, Siberia, between latitudes 70° and 75° north, many skeletons of mammoths, retaining the hair and skin, have been found. The heads of most of these are said to have been turned to the south."

As far as I can find, the distinguished geologist gives no reason why the heads of the mammoths were turned to the south, nor does he say all that I think might be said of the reasons why, and the means by which the skins have been preserved for such a long period of time.

Having lived some years on the banks of two of the great rivers of America, near to where they enter Hudson's Bay, and also on the Mackenzie, which flows into the Arctic Sea, I have had opportunities of observing what takes place on these streams, all of which have large alluvial deposits, forming flats and shallows, at their mouths.

What I know to be of common occurrence in these rivers may, if we reason by analogy, have taken place in ancient times on the great rivers of Siberia, making due allowance for the much higher northern latitude to which these streams run before reaching the sea, and for the difference in size of the fauna that used to frequent their banks.

When animals, more especially those having horns, tusks, or otherwise heavily-weighted heads, are drifting down a river, the position of the bodies may lie in any direction as regards the course of the stream, as long as they are in water deep enough to float them; but the moment they get into a shallow place, the head, which sinks deepest (or, as sailors say, "draws most water"), takes the ground, while the body, still remaining afloat, swings to the current, just as a boat or ship does when brought to anchor in a tideway.

It is probable that the mammoths, having been drowned by breaking through the ice or in swimming across the river in spring when the banks were lined with high, precipitous drifts of snow, which prevented them from getting out of the water, or killed in some other way, floated down stream, perhaps for hundreds of miles, until they reached the shallows at the mouth, where the heads, loaded with a great weight of bone and tusks would get aground in three or four feet of water, while the bodies still afloat would swing round with the current as already described.

The Yenesei flows from south to north, so the heads, being pointed up stream, would be to the south.*

Supposing, then, these bodies anchored as above in three or four feet of water; as soon as the winter sets in, they would be frozen up in this position. The ice in so high a latitude as 70° or 75° north would acquire a thickness of five or six feet at least, so that it would freeze on the bottom on the shallows where the mammoths were anchored. In the spring, on the breaking up of the ice, this ice being solidly frozen to the muddy bottom, would not rise to the surface, but remain fixed, with its contained animal remains, and the flooded stream would rush over both, leaving a covering of mud as the water subsided.

Part of this fixed ice, but not the whole, might be thawed away during summer; and possibly, but not necessarily, next winter a fresh layer of ice with a fresh supply of animal remains might be formed over the former stratum; and so the peculiar position and perfect state of preservation of this immense collection of extinct animals may be accounted for without having recourse to the somewhat improbable theory that a very great and sudden change had taken place in the climate of that region.

I have seen at the mouth of Hayes River in America animals frozen up as above described; but as the latitude of this place is only 57° north, the fixed ice usually wholly disappears before the next winter sets in, and liberates the animals shut up in it; but when the rivers reach the sea, as some of those of Siberia do, 1,000 or 1,200 miles further to the north, it may be fairly assumed that a large part of this fixed ice, protected as it would be by a layer of mud, might continue unthawed.

Addenda.—It is not difficult to account for the remains of mammoths being found in a fresh state in the ice cliffs on the banks of the great Siberian rivers. On these rivers (especially far north) the immense pressure of the water in shoving, forces the ice in great heaps on to the shore, and with the ice any dead animal, which would be preserved for any length of time while the ice cliff remained entire.—*Kansas City Review.*

ON CERTAIN MEANS OF MEASURING AND REGULATING ELECTRIC CURRENTS.†

By C. W. Siemens, D.C.L., F.R.S.

The dynamo-electric machine furnishes us with a means of producing electric currents of great magnitude, and it has become a matter of importance to measure and regulate the proportionate amount of current that shall be permitted to flow through any branch circuit, especially in such applications as the distribution of light and mechanical force. On the 19th of June last, at the soiree of the President of the Royal Society, I exhibited a first conception of an arrangement for regulating such currents, which I have since worked out into a practical form. At the same time, I have been able to realize a method by which currents passing through a circuit, or branch circuit, are measured, and graphically recorded.

It is well known that when an electric current passes through a conductor, heat is generated, which, according to Joule, is proportionate in amount to the resistance of the conductor, and to the square of the current which passes through it in a unit of time, or $H = C^2R$. I propose to take advantage of this well-established law of electro-dynamics, in order to limit and determine the amount of current passing through a circuit.

The most essential part of the instrument is a strip of copper, iron, or other metal, rolled extremely thin, through which the current to be regulated has to pass. One end of this thin strip of metal is attached to a screw, by which its tension can be regulated. It then passes upward over an elevated insulated pulley, and down again to the end of a short lever, working on an axis, armed with a counter weight and with a lever, whose angular position will be materially affected by any small elongation of the strip that may take place from any cause. The apparatus further consists of a number of prisms of metal, supported by means of metallic springs, so regulated by movable weights as to insure the equidistant position of each prism from its neighbor, unless pressed against the neighboring piece by the action of the lever, in consequence of a shortening of the metallic strip. By this action one prism after another would be brought into contact with its neighbor, until the last prism in the series would be pressed against the contact spring, which is in metallic connection with the terminal.

The current passing through the thin strip of metal will, under these circumstances, pass through the lever and the line of prisms to the terminal, without encountering any sensible resistance. A second and more circuitous route is, however, provided between the lever and the terminal, consisting of a series of comparatively thin coils of wire of German silver or other resisting metal, connecting the alternate ends of each two adjoining springs, the first and last spring being also connected to the lever and terminal respectively. When the lever stands in its one extreme position the contact pieces are all separate, and the current has to pass through the entire series of coils, which present sufficient aggregate resistance to prevent the current from exceeding the desired limit.

When the minimum current is passing, the thin metallic strip is at its minimum working temperature, and all the metallic prisms are in contact, this being the position of least resistance. As soon as the current passing through the apparatus shall increase in amount, the thin metallic strip will immediately rise in temperature, which will cause it to elongate, and will allow the lever to recede from its extreme position, liberating one contact piece after another. Each such liberation will call into action the resistance coil connecting the spring ends, and an immediate corresponding diminution of the current through increased resistance; additional resistance will thus be thrown into the circuit, until an equilibrium is established between the heating effect produced by the current in the sensitive strip, and the diminution of heat by radiation from the strip to surrounding objects. In order to obtain uniform results, it is clearly necessary that the loss of heat by radiation should be made independent of accidental causes, such as currents of air or rapid variations of the external temperature, for which purpose the strip is put under a glass shade, and the instrument itself should be placed in a room where a tolerably uniform temperature of say 15° C. is maintained. Under these circumstances, the rate of dissipation by radiation and conduction (considering that we have to deal with low degrees of heat) increases in arithmetical ratio with the temperature of the strip; the expansion of the strip, which affects the position of the lever, is proportionate to the temperature, which is itself proportionate to the square of the current—a circumstance highly favorable to the sensitive action of the instrument.

Suppose that the current intended to be passed through the instrument is capable of maintaining the sensitive strip at a temperature of 60° C., and that a sudden increase of current takes place in consequence either of an augmentation of the supply of electricity or of a change in the extraneous resistance to be overcome, the result will be an augmentation of temperature, which will continue until a new equilibrium between the heat supplied and that lost by radiation is effected. If the strip is made of metal of high conductivity, such as copper or silver, and is rolled down to a thickness not exceeding 0·06 millim., its capacity for heat is exceedingly small, and its surface being relatively very great, the new equilibrium between the supply of heat and its loss by radiation is effected almost instantaneously. But, with the increase of temperature, the position of the regulating lever is simultaneously affected, causing one or more contacts to be liberated, and as many additional resistance coils to be thrown into circuit; the results being that the temperature of the strip varies only between very narrow limits, and that the current itself is rendered very uniform, notwithstanding considerable variation in its force, or in the resistance of the lamp, or other extraneous resistance which it is intended to regulate.

It might appear at first sight that, in dealing with powerful currents, the breaking of contacts would cause serious inconvenience in consequence of the discharge of extra current between the points of contact. But no such discharges of any importance actually take place, because the metallic continuity of the circuit is never broken, and each contact serves only to diminish to some extent the resistance of the regulating rheostat. The resistance coils, by which adjoining contact springs are connected, may be readily changed, so as to suit particular cases; they are made, by preference, of naked wire, in order to expose the entire surface to the cooling action of the atmosphere. In dealing with feeble currents I use another form of regulator in which disks of carbon are substituted for the wire rheostat. The Count du Moncel in 1856, first called attention to, and Mr. Edison more recently took advantage of, the interesting circumstance that the electrical resistance of carbons varies inversely with the pressure to which it is subjected, and by piling several disks of carbon one upon another in a vertical glass tube, a rheostat may be constructed which varies between wide limits, according as the mechanical pressure in the line of the axis is increased or diminished. A steel wire of—say 0·3 millim. diameter is drawn tight between the end of the bell-crank lever and an adjusting screw, the pressure of the lever being resisted by a pile of carbon disks placed in a vertical glass tube. The current passing through the steel wire, through the bell-crank lever, and through the carbon disks, encounters the minimum resistance in the latter so long as the tension of the wire is at its maximum; whereas the least increase in temperature of the steel wire by the passage of the current causes a decrease of pressure upon the pile of carbon disks, and an increase in their electrical resistance; it will thus be readily seen that, by means of this simple apparatus, the strength of small currents may be regulated so as to vary only within certain narrow limits.

The apparatus first described may be adapted also for the measurement of powerful electric currents. The variable rheostat is in this case dispensed with, and the lever carries at its ends a pencil pressing with its point upon a strip of paper drawn under it in a parallel direction with the lever by means of clockwork. A second fixed pencil draws a second or datum line upon the strip, so adjusted that the lines drawn by the two pencils coincide when no current is passing through the sensitive strip. The passage of a current through the strip immediately causes the pencil attached to the lever to move away from the datum line, and the distance between the two lines represents the temperature of the strip. This temperature depends, in the first place, upon the amount of current passing through the strip, and, in the second place, upon the loss of heat by radiation from the strip, which two quantities balance one another during any interval that the current remains constant.

If C is the current before increase of temperature has taken place; R the resistance at the external temperature (T), H the heat generated per unit of time at the commencement of the flow, R′ the resistance and H′ the heat when the temperature T′ and the current C have been attained; then, by the law of Joule, $H' = R' C'^2$. But, inasmuch as the radiation during the interval of constant current and temperature is equal to the supply of heat during the same interval, we have, by the law of Dulong and Petit, $H' = (T' - T) S$, in which S is the radiating surface. Then $R' C'^2 = (T' - T) S$, $C'^2 = (T' - T)\frac{S}{R'}$. But $T' - T$ represents the expansion of the strip or movement of the pencil m, and considering that the electrical resistance of the conductor varies as its absolute temperature (which upon the Centigrade scale, is 274° below the zero Centigrade) according to a law first expressed by Helmholtz, and that we are only here dealing with a few degrees difference of temperature, no sensible error will be committed in putting the value of R for R′, and we have the condition of equilibrium $C'^2 = m\frac{S}{R}$.

$$\therefore C' = \sqrt{m\frac{S}{R}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

or, in words, the current varies as the square root of the difference of temperature or ordinates. For any other condition of temperature T″ we have $C''^2 = \frac{S}{R}(T'' - T)$.

$$\therefore C'' = \sqrt{\frac{S}{R}(T'' - T)},$$

and $(C''^2 - C'^2) = (T'' - T - T' + T)\frac{S}{R} = (T'' - T')\frac{S}{R}$, but for small differences of C″ and C′ we may put $(C''^2 - C'^2) = 2C''(C'' - C')$, that is to say, small variations of current will be proportional to the variation in the temperature of the strip.

In order to facilitate the process of determining the value of a diagram in webers or other units of current, it is only necessary, if the variations are not excessive, to average the ordinates, and to determine their value by equation (1), or from a table prepared for that purpose. The error committed in taking the average ordinate instead of the absolute ordinates, when the current varies between small limits, is evidently small, the variation of the ordinates above their mean value averaging the variations below the same.

The thin sensitive conductor may thus be utilized either to restrict the amount of electricity flowing through a branch circuit, within certain narrow limits, or to produce a record of the amount of current passed through a circuit in any given time.

A NEW BATTERY.

The merits of the Leclanché battery, now so universally used where no great amount of energy is needed, are familiar to all. This form of battery, which, it will be remembered, is charged with peroxide of manganese and sal ammoniac, has the great disadvantage, however, that when once the manganese is used up the element becomes useless, as it cannot be charged a second time. There has been great need, then, of some apparatus like this, which could be easily charged like other batteries. According to a note recently presented to the Society for the Encouragement of National Industry, by M. Marcel, an improved battery of this nature has lately been devised by M. Gaiffe. The new element is arranged thus: The binoxide of manganese is placed in deep holes drilled in a cylindrical piece of carbon, which forms the negative electrode, and which at the same time performs the function of a porous cup. The carbon is placed in a solution of chloride of zinc as an exciting liquid, and an amalgamated zinc rod forms the positive electrode. The solution of the chloride must contain from 15 to 20 per cent. of the zinc salt, and must be free from the presence of lead, and should be as neutral as possible. To insure a perfect contact between the carbon and manganese the latter should be introduced little by little, and well shaken down before adding a further quantity. The manganese should also be of the needle form of variety, and in grains; the powdered kind is inferior. The electro-motive force of this new element is 1·5 Volts, or the electro-motive force of a couple and a half of Daniell. Its constancy it relatively great, and it polarizes very slowly. This polarization disappears, moreover, almost completely when at rest, even when the battery has been scarcely driven. In this battery, as in that of Leclanché, there is no waste of material when the circuit is closed, since the weak solution of zinc chloride has no action on either the manganese or the zinc. An interesting feature in the action of this element is that the oxide of zinc, instead of remaining attached to the zinc, falls in a state of powder to the bottom of the containing vessel, just in proportion as it is formed.

Although the inventor devised this battery for medical purposes, he has also made several forms applicable to various uses: one, 125 millimeters in height, designed for portable medical batteries; another, of 150 millimeters, for large medical batteries and electric annunciators; a third, of 185 millimeters, for telegraphic purposes; and, finally, one 225 millimeters, for such applications as require the simultaneous action of several apparatus.

THE SOLAR SYSTEM

Is composed, according to our present knowledge, of 162 bodies. First, a central body, apparently immovable in the group, much larger than all the others, and self-luminous—the Sun. Second, 124 Planets, situated at increasing distances from the Sun, revolving round him in orbits nearly circular, and receiving from him the light which renders them visible to us. Third, 24 Satellites, revolving round some of the principal planets; such as the Moon, which accompanies the Earth. Fourth, 13 Comets, revolving round the Sun in very elongated orbits. The dimensions of the Sun can scarcely be described so as to get a definite idea of its immensity before the mind. The Moon revolves round the Earth at a mean distance of 30 diameters of our globe. Imagine the center of the Earth to be at exactly at the center of the Sun, not only would the orbit of the Moon lie entirely within the Sun, but to reach the outer rim, a distance equal to 26 Earth-diameters would still remain to be traversed.

* Not many years ago, when buffalo were very abundant on the Saskatchewan, hundreds of them were sometimes drowned in one season while swimming across the river; and many reindeer, moose, and other animals are annually destroyed in this way in other large American rivers.

Sir Charles Lyell mentions a number of yaks being seen frozen up in one of the Siberian rivers, which, on the breaking up of the ice in spring, would be liberated and float down the stream.

† Abstract of a paper presented to the Royal Society, Jan. 30, 1879.